U.S. Department of Energy

Oakland Operations Office, Oakland, California

FINAL
ANNUAL SITE ENVIRONMENTAL REPORT
CALENDAR YEAR 2000

for the

LABORATORY FOR ENERGY-RELATED HEALTH RESEARCH
UNIVERSITY OF CALIFORNIA, DAVIS

Submitted to:

United States Department of Energy
Oakland Operations Office
1301 Clay Street
Oakland, California 94612-5208

Prepared by:

Weiss Associates
5801 Christie Avenue, Suite 600
Emeryville, California 94608-1827

September 2001
Rev. 0

DOE Oakland Operations Contract DE-AC03-96SF20686

Weiss Associates
Environmental and Geologic Services

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Approvals Page

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Department of Energy
Oakland Operations Office
1301 Clay Street
Oakland, California 94612-5208

AUG 3 0 2001

Subject: 2000 Site Environmental Report (SER) for the Laboratory for Energy-Related Health Research (LEHR)

To Whom It May Concern:

The enclosed 2000 LEHR SER prepared by Weiss Associates (WA) summarizes the environmental protection activities at LEHR for calendar year 2000. SERs are prepared annually for all DOE sites conducting significant environmental activities and are distributed to relevant regulatory agencies and other interested parties.

To the best of my knowledge, the 2000 LEHR SER accurately summarizes results for the 2000 Monitoring Program and Restoration Program at LEHR. This assurance is based upon a thorough review by DOE/OAK and WA, and by documented quality assurance protocols applied to the monitoring and data analysis at LEHR.

The 2000 LEHR SER is also available electronically at http://www.oak.doe.gov/DIVISION/LEHR/document.html. Please provide your comments or suggestions for future versions of the report using the enclosed reader survey form. Additionally, your questions or comments on this report may be made directly to DOE/OAK by contacting Richard Fallejo of the Oakland Environmental Programs Division at (510) 637-1639.

Sincerely,

James T. Davis
Assistant Manager
for Environment and
Nuclear Energy

Enclosure

CERTIFICATION OF ACCURACY FOR:

ANNUAL SITE ENVIRONMENTAL REPORT, 2000, FOR LEHR

I certify that the information submitted herein is true, accurate, and complete, based on my familiarity with the information and my inquiry of those individuals immediately responsible for obtaining the information.

Signature: Robert O. Devany Date: 9/12/01
Robert O. Devany, Project Manager

ENVIRONMENTAL REPORT READER SURVEY

To Our Readers:

Each annual Environmental Report publishes the results of environmental monitoring at the Former Laboratory for Energy-Related Health Research (LEHR) and documents our compliance with environmental regulations. In providing this information, our goal is to give our readership — whether they be regulators, scientists, or the public — a clear accounting of the range of environmental activities we undertake, the methods we employ, and the degree of accuracy of our results.

It is important that the information we provide is easily understood, is of interest, and communicates the Department of Energy's effort to protect human health and the environment. We would like to know from you, our readers, whether we are successful in these goals. Your comments are welcome.

1. Is the technical level ❑ too high? ❑ too low? ❑ uneven? ❑ just right?
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3. Do the illustrations help you understand the text better?	❑	❑
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Too many?	❑	❑
4. Is the background information sufficient?	❑	❑
5. Are the methodologies being described understandable?	❑	❑
Interesting?	❑	❑
6. Are the data tables of interest?	❑	❑
Do they provide sufficient information?	❑	❑

Other comments:

_____

_____

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A business reply envelope has been attached for returning these surveys to Weiss Associates, 5801Christie Avenue, Suite 600, Emeryville, CA 94608.

OPTIONAL

Name: _____ Occupation _____

Address: _____

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TABLES

FIGURES

APPENDIX

ACRONYMS AND ABBREVIATIONS

ALARA	As-Low-As-Reasonably-Achievable
ASER	Annual Site Environmental Report
bgs	below ground surface
Bi-214	bismuth-214
C-14	carbon-14
CEQA	California Environmental Quality Act
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
CFR	Code of Federal Regulations
Co-60	cobalt-60
COC(s)	constituents of concern
cm/sec	centimeters per second
CRDL	contract-required detection limit
cu yd	cubic yard
CVRWQCB	Central Valley Regional Water Quality Control Board
D&D	Decontamination and Decommissioning
DCG(s)	Derived Concentration Guideline(s)
DOE	United States Department of Energy
DTSC	California Department of Toxic Substances Control
EDE	effective dose equivalent
EDPs	Eastern Dog Pens
EE/CA	Engineering Evaluation/Cost Analysis
EPA	United States Environmental Protection Agency
EPCRA	Emergency Planning and Community Right to Know Act
ER/WM	environmental restoration/waste management
FFA	Federal Facility Agreement
ft	feet
GEPP	General Environmental Protection Program
HSU	hydrostratigraphic unit

IDW	investigation-derived waste
IRA	interim remedial action
ITEH	Institute for Toxicology and Environmental Health (UC Davis)
LEHR	Laboratory for Energy-Related Health Research
MCL	maximum contaminant level
MDA	minimum detectable activity
MEI	maximally exposed individual
mg/L	milligrams per liter
MOA	Memorandum of Agreement
mrem/yr	millirem per year
MSDS	Material Safety Data Sheets
MWSF	Mixed Waste Storage Facility
NCP	National Contingency Plan
NEPA	National Environmental Policy Act
NESHAP	National Emission Standards for Hazardous Air Pollutants
NPDES	National Pollutant Discharge Elimination System
PCB	polychlorinated biphenyl
PCD	Putah Creek Downstream
pCi/g	picoCuries per gram
pCi/L	picoCuries per liter
pCi/m^3	picoCuries per cubic meter
PCU	Putah Creek Upstream
PM-10	respirable particulate matter (less than 10 microns)
PNNL	Pacific Northwest National Laboratory
QA	quality assurance
QAPP	Quality Assurance Project Plan
QC	quality control
RA	removal action
Ra-226	radium-226
Ra/Sr	Radium/Strontium
RBAS	Risk-Based Action Standard
RCRA	Resource Conservation and Recovery Act

rem	Roentgen Equivalent Man
RPP	Radiation Protection Plan
Sr-90	strontium-90
STPO	wastewater (sewage) treatment plant outfall
SVOC	semi-volatile organic compound
TDS	total dissolved solids
TLD	thermoluminescent dosimeter
UC Davis	University of California, Davis
U.S.	United States
VOC	volatile organic compound
WA	Weiss Associates
WDPs	Western Dog Pens
WDR	waste discharge requirement
YSAQMD	Yolo-Solano Air Quality Management District
µg/L	micrograms per liter

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SUMMARY

This Annual Site Environmental Report (ASER) for the Laboratory for Energy-Related Health Research (LEHR) site at the University of California, Davis (UC Davis) (the Site) summarizes 2000 environmental monitoring data for air, soil, ground water, surface water, storm water and ambient radiation. The U.S. Department of Energy (DOE) operation of LEHR as a research location ceased in 1989 after three decades of research on the health effects of low-level radiation exposure (primarily strontium-90 [Sr-90] and radium-226 [Ra-226]), using beagles to simulate effects on human health. During 2000, DOE continued environmental remediation activities at the Site to comply with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA).

Progress of Site Environmental Restoration

Site restoration activities are conducted by DOE and UC Davis in coordination with the U.S. Environmental Protection Agency (EPA), the California Department of Toxic Substances Control (DTSC), the Central Valley Regional Water Quality Control Board (CVRWQCB) and the California Department of Health Services (DHS).

Under the Federal Facilities Agreement effective in December 1999, DOE is responsible for remediation of the Ra-226 and Sr-90 leach fields and tanks, DOE buried disposal box, on-site domestic septic systems, DOE disposal trenches, and the dog pens (Figure 1-2). UC Davis is responsible for three landfills, disposal trenches located south and east of the Landfill No. 2, 49 waste holes, an old waste water treatment plant, ground water impacted at the Site, and surface and storm water runoff impacted by UC Davis (Figure 1-2).

DOE activities at the Site in 2000 consisted primarily of the Radium/Strontium (Ra/Sr) Treatment Systems Area II Removal Action (RA), and the shipping of low-level radioactive waste generated during the 1998 Southwest Trenches and 1999 Ra/Sr Treatment Systems Area I RAs and investigation derived waste (IDW) stored in the Cobalt-60 Field Waste Storage Area (Figure 1-2).

Significant site restoration progress was made during the year. Ongoing monitoring and characterization of air, soil and water were performed to meet data requirements and to evaluate RA options. Significant activities in 2000 included:

- ***Ra/Sr Treatment Systems Area II RA:*** Approximately 1,500 cubic yards (cu yds) of low-level waste (concrete, cobbles, soil, piping) and 40 cu yds of overburden soil were removed from the Ra/Sr Treatment Systems Area II, located on the western side of the Site (Figure 1-2). The RA was implemented in two phases: during the first phase of the RA, the Sr-90 leachfield and associated piping for both the Ra-226 and Sr-90 tanks were removed. The second phase of the Area II RA consisted of removing the Ra-226/Sr-90 tanks. Confirmation samples were collected at the completion of the excavation

activities. A detailed discussion of the results will be included in the Ra/Sr Treatment Systems Confirmation Report to be completed in September 2001.

- ***Asbestos Removal:*** Approximately 10 cu yds of roofing material containing asbestos were removed from the Sr-90 tanks prior to their demolition. The asbestos removal was conducted by a California certified asbestos abatement contractor.
- ***Waste Disposal:*** Approximately 21 cu yds of waste generated during the 1998 Southwest Trenches RA, 80 cu yds of IDW stored in the Cobalt-60 field waste storage area, and 250 cu yds of waste generated during the Ra/Sr Treatment Systems Area I RA were disposed off site at approved facilities.
- ***Western Dog Pens Engineering Evaluation/Cost Analysis (EE/CA):*** An EE/CA for the Western Dog Pens (WDPs) was finalized in February 2001.

Overview of 2000 Water Environmental Monitoring Results

In July 2000, the water monitoring program was modified to accommodate a UC Davis Land Treatment Pilot Study and to incorporate recommendations provided in the 1998 Annual Water Monitoring Report (Dames and Moore, 2001). The monitoring program analyte list was also modified in 2000. The revised program focuses on the primary ground water constituents of concern (COCs) for both HSU-1 and HSU-2, and reduced HSU-1 monitoring locations and frequency. Two additional monitoring wells were installed in May 2000 (Dames and Moore, 2001).

Storm water and surface water samples were collected twice in 2000. The analytic results were consistent with previous years, and no new trends or concerns were identified.

Ground water samples were collected from 30 wells at frequencies ranging from monthly to annually. Analytic results were similar to previous years: elevated concentrations of chloroform and associated volatile organic compounds, chromium, total dissolved solids, tritium and carbon-14 (C-14) are present in site ground water. However, concentrations of tritium, C-14 and chloroform are decreasing in the shallow aquifer.

Overview of 2000 Air Environmental Monitoring Results

The Site air monitoring program was modified in 1999. The modified program continues monitoring of alpha, beta and radon levels, and provides monitoring of additional compounds before, during and after RAs. Monitoring at off-site station AM-6 was discontinued, and background information is now monitored at off-site station AM-3 (Figure 4-1).

The results of the radionuclide air monitoring program are similar to previous years. Total alpha and beta activities detected at the Site were similar to off-site background levels. All gamma-emitting radionuclides detected were well below the DOE Derived Concentration Guidelines.

Radiological Impact Assessment of the LEHR Environmental Restoration Project

The Ra/Sr Treatment Systems Area II RA was the primary DOE environmental activity at the Site in 2000. The removal of waste from this area will reduce the long-term risk of radiological

exposure at the Site. The radiological air and ambient data all indicate that the low radionuclide activities detectable at the Site in 2000 were near or below natural background levels, and do not pose a risk to site workers or the general public.

1. INTRODUCTION

This Annual Site Environmental Report (ASER) describes Calendar Year 2000 United States (U.S.) Department of Energy (DOE) environmental restoration/waste management (ER/WM) activities at the Laboratory for Energy-Related Health Research (LEHR) Site (the Site) at the University of California, Davis (UC Davis) (Figure 1-1). This report was prepared according to the requirements of DOE Order 5400.1, General Environmental Protection Program (GEPP) and DOE Order 231.1 Environmental Safety and Health Reporting. The purpose of this report is to summarize environmental data, confirm compliance with environmental standards and requirements and highlight significant programs and efforts. This report describes activities conducted by DOE during 2000 in support of the Site environmental restoration efforts, and provides information about the impact of these activities on the public and the environment. The ground water monitoring program is performed by UC Davis that includes information important to the overall environmental restoration of the Site, is also briefly summarized. The UC Davis programs discussed in this report are not required to follow the requirements of DOE Order 5400.1.

1.1 Site History

The Atomic Energy Commission first sponsored radiological studies on laboratory animals at UC Davis in the early 1950s. Initially situated on the main campus, LEHR was established in 1958 at its present location in 1958 (Figure 1-1). Research at LEHR through the mid-1980s focused on the health effects from chronic exposures to radionuclides, primarily strontium-90 (Sr-90) and radium-226 (Ra-226), using beagles to simulate radiation effects on humans. Other related research was conducted at the Site concurrent with these long-term studies. In the early 1970s, a cobalt-60 (Co-60) irradiator facility was constructed at the Site to study the effects of chronic exposure to gamma radiation on beagles.

A campus landfill with two waste burial units that were used from the 1940s until the mid-1960s is located at the Site (Figure 1-2). Several low-level radioactive waste burial areas were also present at the Site and have been the subject of several removal actions (RAs) conducted since 1998. Campus and LEHR research waste were buried in these areas until 1974, in accordance with regulations in effect at the time.

In 1988, pursuant to a Memorandum of Agreement (MOA) between DOE and the University of California, DOE's Office of Energy Research initiated activities to close out the research program at LEHR. In 1997, a second MOA divided the responsibility for environmental restoration between DOE and UC Davis.

Under the Federal Facilities Agreement effective in December 1999, DOE is responsible for remediation of the Ra-226 and Sr-90 leach fields and tanks, DOE buried disposal box, on-site domestic septic systems, DOE disposal trenches, and the dog pens (Figure 1-2). UC Davis is

responsible for three landfills, disposal trenches located south and east of the Landfill No. 2, 49 waste holes, an old waste water treatment plant, ground water impacted at the Site, and surface and storm water runoff impacted by UC Davis (Figure 1-2).

DOE activities at the Site in 2000 consisted primarily of the Radium/Strontium (Ra/Sr) Treatment Systems Area II RA, and the shipping of waste generated during the 1998 Southwest Trenches and 1999 Ra/Sr Treatment Systems Area I RAs and investigation derived waste (IDW) stored in the Cobalt-60 Field Waste Storage Area (Figure 1-2).

In 1999, a Federal Facility Agreement (FFA) was signed by DOE and regulatory agencies. The FFA governs clean up activities and regulatory oversight, as discussed in more detail in Section 2 of the 1999 ASER (WA, 2000e).

1.1.1 Environmental Restoration

The DOE Oakland Operations Office manages the environmental restoration of the DOE-impacted areas of the Site. From October 1989 through February 1990, an interim contract with UC Davis was implemented to begin site restoration. From 1990 to 1996, Battelle Environmental Management Operations managed the LEHR ER/WM project. In 1996, the project was transferred to Weiss Associates (WA) of Emeryville, California.

In May 1994, the U.S. Environmental Protection Agency (EPA) added the Site to the National Priorities List. A site Remedial Investigation and Feasibility Study work plan was developed to ensure that investigation and remediation were conducted in accordance with regulatory requirements. Remedial Project Manager (RPM) meetings are held monthly to evaluate the progress of remediation and identify actions needed to facilitate the process.

Primary DOE restoration/remediation activities that have been or will be performed at the Site include: soil and ground water characterization; building assessment; decontamination and decommissioning (D&D) of above-ground structures; waste management; chemical and radiological risk assessment; and remediation of contaminated trenches, soil, and underground tanks. Project management, health and safety, and quality assurance (QA) are components of all actions undertaken on behalf of DOE.

1.2 Site Description

The Site is a 15-acre parcel owned by the Regents of the University of California. It is 1.5 miles south of the main UC Davis campus in a rural agricultural area (Figure 1-1), and is presently occupied by the UC Davis Institute of Toxicology and Environmental Health (ITEH). Research at ITEH includes toxicology, epidemiology, radiation biology and radiochemistry.

The Site consists of 15 buildings, including a main administration and office building, two animal hospitals, a laboratory and support buildings. Historical use of specific facilities and/or areas at the Site that have impacted the environment are being investigated and remediated. Former facilities include: radioactive wastewater treatment systems, an indoor/outdoor Co-60 irradiator, a

radioactive waste burial area, animal hospitals and outdoor dog pens. Potential environmental impacts from the inactive campus landfill units and numerous inactive campus low-level radioactive disposal sites (i.e., trenches and holes) used to dispose waste are also being evaluated by UC Davis. Figure 1-2 shows areas that have potentially impacted the environment at the Site.

1.3 Population Data

1.3.1 Site Population

Currently, the Site is used by UC Davis and DOE to support ongoing research and remediation, respectively. UC Davis ITEH consists of several site research facilities involving approximately 200 university researchers and support staff. ITEH researchers and student assistants have varying schedules and are not all present at the Site at the same time.

The DOE LEHR ER/WM Project is currently managed and staffed by WA and its subcontractors. Total LEHR ER/WM Project on-site personnel currently include up to six full-time workers. This number increases to approximately 15 workers when on-site remediation and waste management projects are in progress.

1.3.2 Local Population

The Site is located in a rural area in northeast Solano County just outside of Davis, California (Figure 1-1). UC Davis has a student population of approximately 25,000 and employs approximately 15,000 full-time faculty and staff. The estimated 2000 population of Davis is approximately 60,300 and the estimated total population of Yolo County is about 168,700 (United States Census Bureau, 2001). The more densely populated and metropolitan Sacramento area is approximately 12 miles east of the Site. The current population of Sacramento County is about 1,223,500, and approximately 407,000 people live in the city of Sacramento (United States Census Bureau, 2001).

1.4 Environmental Setting

The Site is located on a relatively flat plain bordered on the south by Putah Creek. The Site is mostly open, slopes gently to the east, and has a few trees and bushes. The Site lies outside the 100-year floodplain.

1.4.1 Land Use

The land within a one-mile radius of the Site is owned both privately and by UC Davis. It is used for animal research, agriculture and recreation (i.e., fishing and swimming). Privately owned

lands south and east of the Site are used to produce wheat, tomatoes, corn, barley and oats and include permanent residences. Private property to the south is separated from the Site by the South Fork of Putah Creek, and private property to the east is adjacent to non-LEHR, UC Davis-owned research facilities. The property immediately west, north and south of the Site (Putah Creek Reserve) is owned by UC Davis and is currently used for various types of animal, agricultural and health research.

1.4.2 Hydrogeology

Unconsolidated Pliocene and Pleistocene sedimentary deposits are the major ground water sources for public and private water supplies in the Sacramento Valley (DWR, 1978). Both unconfined and confined fresh water aquifers are present in the uppermost 3,000 feet (ft) of the valley subsurface. Ground water generally flows from the valley sides towards the valley axis. In the vicinity of the Site, regional ground water generally flows east from the Coast Ranges toward the Sacramento River (Dames & Moore, 1993).

At various depths beneath the valley floor, saline water is present as a result of entrapment during the deposition of sediments in a marine environment. The depth to the base of fresh water in the Sacramento Valley varies from 400 ft to over 3,000 ft, and is 2,600 ft to 3,100 ft below ground surface (bgs) in the Davis area (Division of Oil & Gas, 1982).

Previous investigations identified five hydrostratigraphic units (HSUs) beneath the Site (Dames & Moore, 1999). These include the vadose zone and HSUs 1 through 4. The vadose zone extends from the ground surface to the top of ground water, which has historically ranged from 15 ft to 55 ft bgs. The vadose zone consists primarily of unsaturated clay and silt with lesser amounts of interbedded sand and gravel. HSU-1 extends from the bottom of the vadose zone to a depth of approximately 76 ft to 88 ft bgs. This unit is lithologically similar to the vadose zone and consists primarily of silt and clay, with lesser amounts of sand and gravel. HSU-2 extends from the bottom of HSU-1 to a depth of approximately 114 ft to 130 ft bgs. This unit is composed primarily of sand in the upper portion of the unit and gravel in the middle to lower portions. HSU-3, investigated in off-site areas, extends from the bottom of HSU-2 to a depth of about 250 ft bgs and is approximately 120 ft thick. The unit consists primarily of relatively fine-grained sediments varying from very fine-grained sandy silt to clayey silt and silty clay. HSU-4, also investigated in off-site areas, extends from the bottom of HSU-3 to a depth of about 282 ft bgs and is approximately 32 ft thick. This unit consists of coarse sand and gravel. Beneath HSU-4, a sharp contact with a bluish, dark gray silt was encountered at 282 ft bgs in wells UCD4-41 and UCD4-43. The bottom of this unit has not been penetrated in any of the Site borings (Dames & Moore, 1999).

The uppermost distinct aquifer beneath the Site has been divided into two HSUs (HSU-1 and HSU-2), based on the stratigraphy of the sediments at the Site and the associated ground water flow and contaminant migration characteristics (Dames & Moore, 1994). Well drillers' logs indicate that a 90-ft-thick clay unit separates HSU-2 from a second aquifer below (Dames & Moore, 1994).

Irrigation water, rainfall and Putah Creek recharge ground water in the vicinity of the Site (Dames & Moore, 1997). The main component of ground water recharge, however, has been identified as irrigation water infiltration (WA, 1998a). Ground water pumping associated with

agriculture is responsible for the great majority of ground water withdrawal. In addition, UC Davis extracts ground water from HSU-2 as part of its interim remedial actions (IRA).

Generally, there is a 20-ft to 30-ft seasonal fluctuation in the depth-to-ground water beneath the Site caused predominantly by the lack of surface recharge and nearby agricultural pumping in the summer. Vertical gradients vary both temporally and spatially. The magnitude of the vertical gradient is greatest when ground water elevations are rising or falling sharply. Short-term activities such as local agricultural pumping can produce downward vertical gradients during periods of an otherwise rising water table.

The HSU-1 lateral gradient across the Site typically ranges from 0.01 ft/ft to 0.04 ft/ft, and the direction of ground water flow is predominantly northeast. Representative values of HSU-1 horizontal hydraulic conductivity are between 1×10^{-4} and 1×10^{-7} centimeters per second (cm/sec) (Dames & Moore, 1999). The lateral gradient across the Site within HSU-2 typically ranges from 0.005 ft/ft to 0.015 ft/ft. The direction of flow appears to be predominantly northeast, although it can occasionally be east-southeast. Based on pumping tests, hydraulic conductivity in HSU-2 ranges from 0.26 cm/sec to 0.43 cm/sec (Dames & Moore 1997).

Ground water in HSU-1, HSU-2 and HSU-4 has been impacted by site activities. Based on investigations to date (WA, 1997a; WA, 1999a), significant ground water impact appears to be associated only with the UC Davis disposal areas.

1.4.3 Water Supply and Quality

Ground water in the vicinity of the Site is used for agricultural and domestic supply. Regional ground water quality has been impacted by nitrates, probably from agricultural sources, and by hexavalent chromium, probably from natural sources.

Local ground water is recharged by streams and rivers, and direct infiltration from precipitation and irrigation. At the Site, recharge rates are highest immediately after precipitation events. Within a day after a heavy precipitation event, continuous water level measuring equipment located in monitoring wells near the creek show a significant increase (DOE, 1996).

1.4.4 Sanitary Sewer Systems

The Site discharges its sanitary wastewater to the UC Davis Wastewater Treatment Plant. UC Davis operates the plant under the conditions specified in its National Pollutant Discharge Elimination System (NPDES) permit, granted by the EPA in conjunction with the Central Valley Regional Water Quality Control Board (CVRWQCB).

1.4.5 Storm Drainage System

Storm water runoff at the Site is collected in an underground drainage system. Storm water from the paved area in the west part of the Site and around the southern buildings in the western area is collected in a storm water drainage system. The drainage system flows to the site storm water lift station (LS-1 on Figure 1-3), and then to an outfall along the west side of the Old Davis Road where it is discharged to Putah Creek. Storm water in the northwestern area of the Site drains into a ditch along Old Davis Road. Storm water in the eastern and non-paved southern portions of the Site percolates into the ground, except for a section of the former Co-60 Field where dog pens were once located, and where drainage is connected to the sanitary sewer. Water ponds in some areas of the Site during heavy rains.

1.4.6 Biological Resources

A number of sensitive biological resources were identified in an Ecological Scoping Assessment (WA, 1997b) as potentially occurring in the vicinity of the project site. These species include the Giant Garter Snake, the Northern Harrier, the Coopers Hawk, the California Horned Lark, the Great Egret, the Burrowing Owl and the Valley Elderberry Longhorn Beetle, which lives in elderberry bushes. Although elderberry bushes are present at the Site, a focussed biosurvey (IT Corp, 1998) found no sensitive species actually present on site and concluded that the on-site elderberry bushes are not currently hosting the Valley Elderberry Longhorn Beetle.

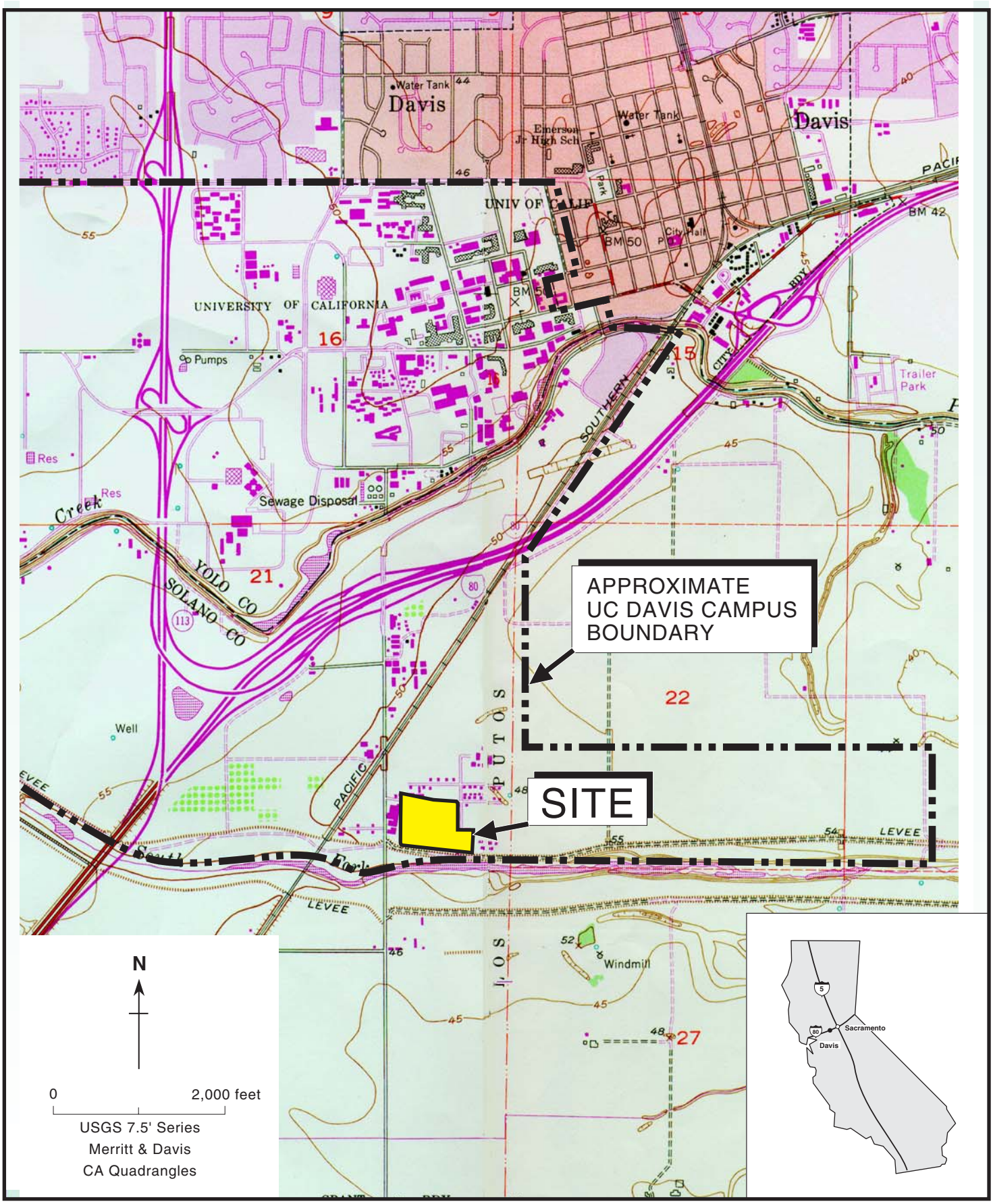

Figure 1. Location of the LEHR Site, UC Davis, California

Weiss Associates

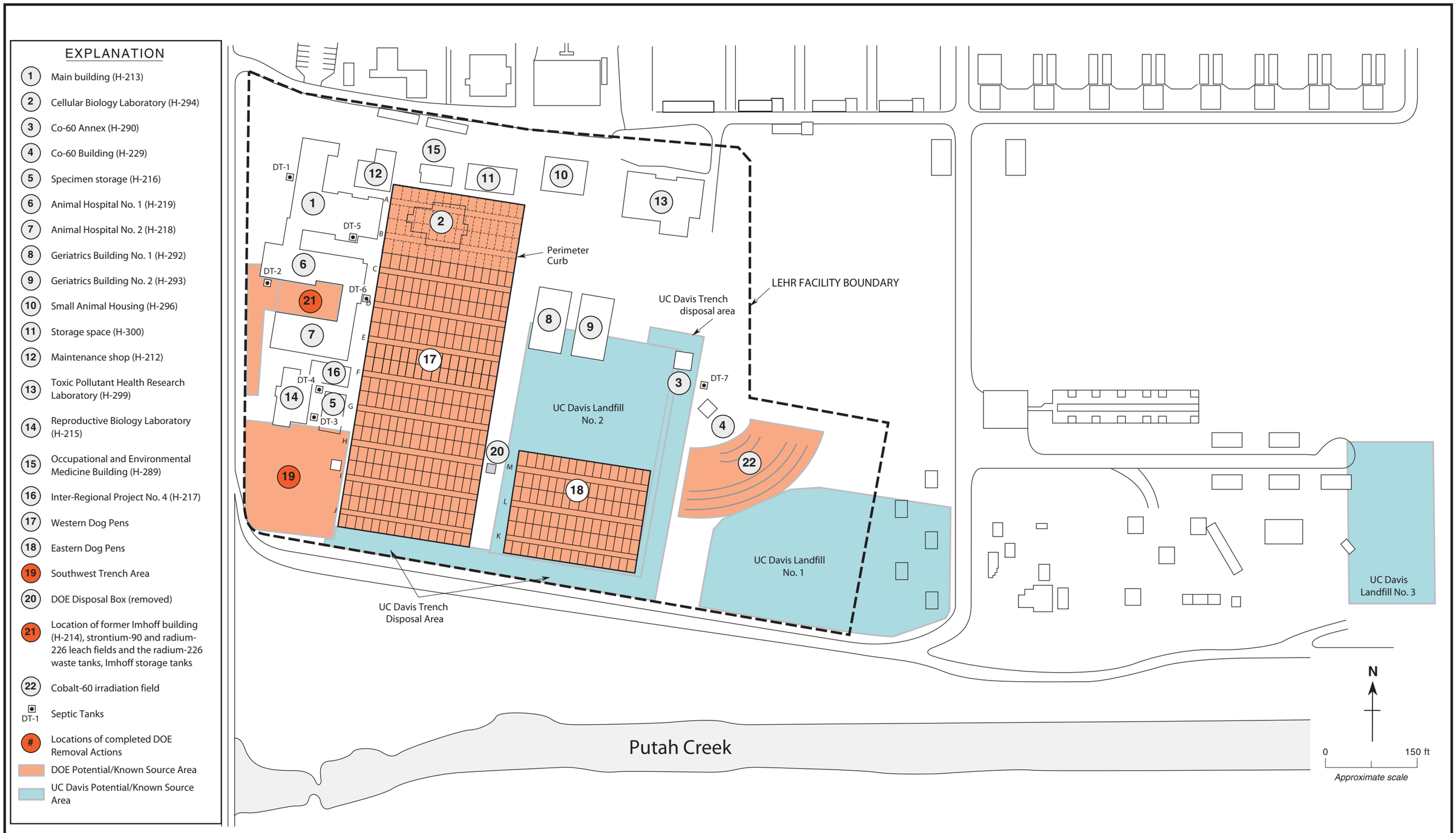

Figure 1-2. Site Features and Areas of Potentially Known Contamination Source Areas

Weiss Associates

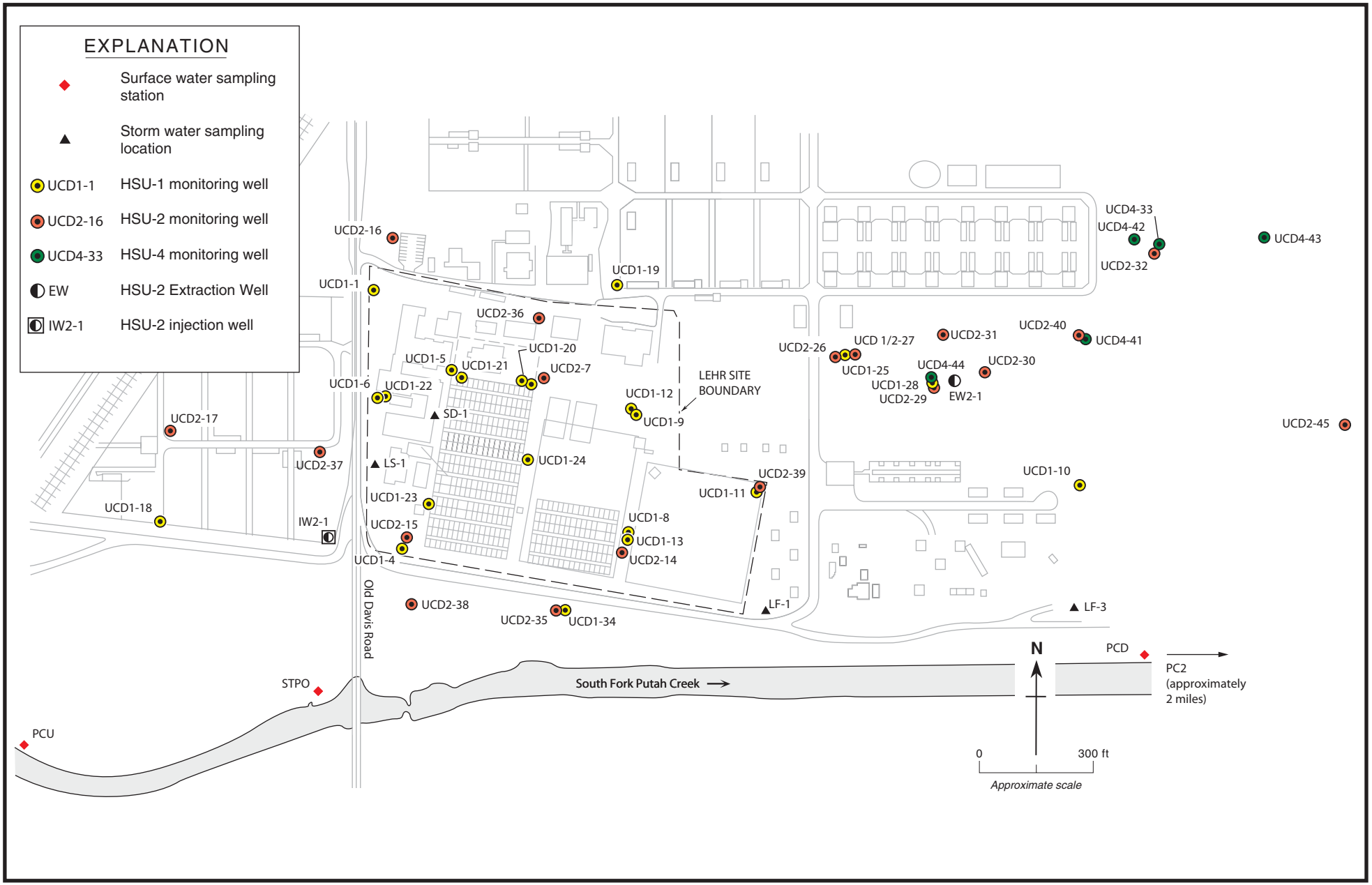

Figure 1-3. Monitoring Well, Storm Water and Surface Water Monitoring Locations, LEHR Site, UC Davis, California

Weiss Associates

2. COMPLIANCE SUMMARY

This section summarizes environmental regulatory compliance status for 2000 LEHR activities. DOE-funded work at the Site centered on ER/WM activities.

2.1 Comprehensive Environmental Response, Compensation and Liability Act

In 1995, a streamlined Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) process was initiated at the Site that encourages an interactive remedial decision-making framework, wherein data are evaluated and cleanup actions are implemented in an ongoing process. An RA in the Ra/Sr Treatment System Area and continued characterization of site soil and air were the primary focus of DOE 2000 CERCLA compliance actions. No violations, fines or penalties were issued for the Site in 2000.

2.2 Resource Conservation and Recovery Act

No RCRA hazardous waste or mixed waste (radioactive waste mixed with RCRA hazardous waste) was generated or stored on site in 2000. All potential mixed waste pending analysis is managed in compliance with substantive RCRA requirements.

2.2.1 Mixed Waste Storage Facility

In 1989, UC Davis (as operator) and DOE (as owner) submitted a Part A permit application to EPA for the on-site storage of mixed waste generated during decontamination and decommissioning D&D activities. The waste was stored in the Mixed Waste Storage Facility (MWSF) located in the eastern part of the Site (Figure 1-2). The MWSF operated under RCRA interim status. The facility consisted of a pre-fabricated steel chemical storage building with three separate lockers that were used to store mixed waste between 1989 and 1996. All stored waste has been properly characterized, packaged and shipped to off-site locations for treatment or disposal, and the MWSF is now empty.

A closure plan was submitted by the Department of Toxic Substances Control (DTSC) for public comment in April 1999. DTSC approved closure of the facility in March 2000. The RCRA interim status is therefore no longer applicable at the Site. A request was submitted in April 2000 to the EPA to rescind the RCRA interim status. However, a response from EPA on this matter has not been received to date.

2.3 Federal Facilities Compliance Act

The Federal Facilities Compliance Act amends the Solid Waste Disposal Act and states that all Federal agencies are subject to all substantive and procedural requirements of Federal, state, and local solid and hazardous waste laws in the same manner as any private party. The act requires that a Site Treatment Plan be prepared for each DOE site that generates or stores mixed radioactive waste. After completion of the California Environmental Quality Act (CEQA) Initial Study and public comment, a final Site Treatment Plan for LEHR was approved and issued in October 1995. No revisions have been made to this plan, and no mixed waste was generated in 2000.

2.4 National Environmental Policy Act

An Engineering Evaluation/Cost Analysis (EE/CA) for the Southwest Trenches, Ra-226/Sr-90 Treatment Systems and Domestic Septic System Areas was completed in early 1998 (WA, 1998b). The EE/CA reviewed environmental impacts in a manner that is consistent with the National Environmental Policy Act (NEPA) and with DOE environmental compliance guidelines. In 2000, the NEPA mitigation measures required in the EE/CA were implemented during the Ra/Sr Treatment Systems RA.

An EE/CA for the Western and Eastern Dog Pens (WDPs) was prepared in 2000 and submitted in February, 2001. The EE/CA evaluates environmental impacts in a manner consistent with NEPA and with DOE environmental compliance guidelines. The EE/CA found that the RA would present no significant impacts to the human environment. In preparing the EE/CA, a field measurement instrumentation pilot study was conducted to determine the most cost effective and technically feasible approach to the WDPs remedial action.

2.5 Radiation Protection of the Public and the Environment

All work at LEHR is performed in compliance with the LEHR Radiation Protection Plan (RPP) (WA, 1999b) and the As-Low-As-Reasonably-Achievable (ALARA) program (WA, 2001b) which comply with 10 Code of Federal Regulations (CFR) 835. The RPP and ALARA programs require that all work performed at LEHR be conducted in a manner that protects the public and the environment from radiological hazards.

In addition the RPP and ALARA programs, the LEHR QAPP (WA, 2000d) requires that environmental monitoring aspects of all operations and activities at LEHR are addressed in the work plans developed for specific activities. A comprehensive environmental monitoring program compliant with DOE Order 5400.1 General Environmental Protection Program and DOE Order 5400.5, Radiation Protection of the Public and the Environment, is being developed and is scheduled to be final in September 2001.

2.6 Radioactive Waste Management

Waste managed at LEHR consists of contaminated soil and debris generated during remedial activities, small amounts of remaining laboratory legacy materials and waste generated during the decontamination and decommissioning (D&D) of LEHR facility buildings and structures. To date, LEHR has managed this waste under task specific waste management plans. A comprehensive *Radioactive Waste Management Plan* (WA, 2001c) has been developed and existing standard operating procedures for waste management have been updated to meet the requirements of DOE Order 435.1. A Draft Radioactive Waste Management Basis has been developed and submitted to DOE for review and is expected to be finalized by September 30, 2001.

2.7 California Environmental Quality Act

No CEQA documentation was processed or required in 2000.

2.8 Clean Air Act

The Site is subject to Yolo-Solano Air Quality Management District (YSAQMD) regulations. A notice was provided to the YSAQMD prior to removal of asbestos containing material during remediation activities performed in 2000 and a YSAQMD inspection was conducted to verify compliance with relevant asbestos regulations. Air monitoring was performed by a licensed asbestos contractor during the asbestos removal activities and confirmed that no hazard to the workers or the public was created during this work.

Currently, no other sources of air pollution at the Site are subject to permit requirements. Verification of site compliance with clean air regulations is accomplished through localized air monitoring during RAs. Site ambient air monitoring was conducted from 1995 through 2000 and computer simulations indicate that surface soil contamination does not impact air quality at the Site.

As various environmental restoration activities progress at the Site, the need for additional air monitoring is evaluated during restoration activities. The potential exists for some of the contamination in burial areas to become exposed during tests and excavation. Prior to the start of each phase of a project, an analysis is performed to determine required controls to reduce potential emissions and to evaluate air monitoring requirements. Monitoring data are collected before, during and after the activity to verify that controls are maintained and requirements are met.

2.8.1 National Emission Standards for Hazardous Air Pollutants

The Site complies with the CFR, 40 Part 61 Subpart H – *National Emissions Standards for Hazardous Air Pollutants (NESHAP) for Emissions of Radionuclides from DOE Facilities.* The NESHAP regulations require that radionuclide emissions not exceed levels that would result in an effective dose equivalent (EDE) of 10 millirems per year (mrem/yr).

There are currently no point sources of radionuclide emissions at the Site. The NESHAP requirements primarily target point source/stack emissions. However, a Memorandum of Understanding between the DOE and the EPA (DOE, 1995) applies the same criteria to potential diffuse area sources that are required of point sources.

Calculations were performed to determine the estimated dose in 2000 to the public from the Site's diffuse area sources. These calculations were based on site residual surface soil contamination (diffuse sources). The potential sources of emissions at the Site during 2000 were re-entrainment and dispersion of surface soil dust containing potentially elevated concentrations of radionuclides, as well as disturbances from excavation activities which took place in the summer of 2000 at the Ra/Sr Treatment Systems Area. Estimated contributions to the annual site EDE from non-point source emissions (surface soils) are well below the NESHAP limit, as shown in Table 4-2.

An analysis of potential diffuse airborne radiological effluent sources at the Site are included in the 2000 Calendar Year Radionuclide Air Emission Annual Report (under Subpart H of 40 CFR Part 61) submitted in June 2001. Fugitive emissions modeling indicated that the maximum annual credible dose equivalent to a member of the public from residual contamination on the Site is 7.52×10^{-4} mrem/yr, far below the 10 mrem/yr NESHAP EDE. This analysis is discussed in more detail in Section 4 of this report.

2.9 National Pollutant Discharge Elimination System

Some surface water discharged from the Site in 2000 was directed to the UC Davis Wastewater Treatment Plant. Wastewater from this plant is discharged to the south fork of Putah Creek. This discharge is monitored by UC Davis under NPDES Permit No.CA0077895 (EPA) and Waste Discharge Requirement (WDR) Order No. 92-040 (CVRWQCB).

2.10 Clean Water Act

The Site discharges its sanitary waste to the UC Davis Wastewater Treatment Plant which is subject to the conditions in NPDES permit CA0077895 and WDR Order No. 92-040, granted by the CVRWQCB. DOE operations at the Site do not include any underground or above-ground tanks that are subject to any county, state or federal permit requirements.

Storm water samples are usually collected twice a year, once near the beginning of the rainy season after the first significant storm of the season, and once near the end of the season. Grab samples were collected from three locations at the Site in 2000: LF-1, LF-3 and LS-1. Storm water sample locations are shown on Figure 1-3. Although the Site does not fall under the industrial categories subject to the State General Storm Water Permit requirements, the storm water sampling program meets the State General Permit requirements and is performed in accordance with the Revised Field Sampling Plan (Dames & Moore, 1998). Best management practices are also in use at the Site to mitigate any potential contamination in storm water runoff.

2.11 Safe Drinking Water Act/California Porter-Cologne Water Quality Control Act/California Safe Drinking Water and Toxics Enforcement Act (Proposition 65)

Current DOE activities at LEHR do not contribute to hazardous discharges. The facilities at LEHR that historically released liquid effluent to the environment, the Imhoff Treatment Facility, the Domestic Septic Tanks and the Ra-226 Septic System, have ceased operation and have been or will be the subject of RAs. DOE research operations at the Site were discontinued in 1989.

Quarterly ground water and surface water monitoring has been conducted since November 1990 and focuses primarily on environmental surveillance activities and monitoring performance of the UC Davis Ground Water Interim Remedial Action (IRA). Ground water and surface water monitoring in 2000 were conducted under the Revised Field Sampling Plan (Dames & Moore, 1998).

2.12 Executive Order 13148, "Greening the Government Through Leadership in Environmental Management"

A program is being developed in accordance to Executive Order 13148 and DOE Notice 450.4 that will integrate existing pollution prevention and waste management programs with LEHR's integrated safety management program.

The relevant requirements of SARA Title III, Emergency Reporting and Community Right-to-Know Act (EPCRA) are complied with at LEHR. The LEHR Project Health and Safety Plan contains a Hazard Communication program, including chemical inventory and Material Safety Data Sheet (MSDS) requirement of EPCRA Sections 311-312, MSDS/Chemical Reporting. The planning notification requirement of EPCRA Section 302-303, Planning Notification, are covered by the LEHR Contingency Plan and General Emergency Response Procedures (WA, 2000a). Compliance with EPCRA Section 304, Release Notification is addressed in the LEHR CPGERP and the LEHR Occurrence Reporting Plan (WA, 2000b). The Site is not required to provide toxic release inventory reporting under EPCRA Section 313, TRI Reporting. Site compliance with reporting requirements of this regulation is summarized in Table 2-1.

2.13 Toxic Substances Control Act: 40 Code of Federal Regulations 763; and Demolition/Renovation Involving Asbestos: National Emission Standards for Hazardous Air Pollutants Subpart M, 40 Code of Federal Regulations 61.14

An asbestos-bearing pipe was removed in 2000 during the Ra/Sr RA. This pipe was properly packaged and is currently being characterized for proper off-site disposal.

During demolition of the Sr-90 tanks, a California certified asbestos abatement contractor removed 10 cu yds of tank roof material containing asbestos. This material is currently being characterized for proper off-site disposal.

2.14 Federal Insecticide, Fungicide and Rodenticide Act

Approved herbicides were used at the Site in 2000 by UC Davis Agricultural Services Department personnel to control weeds. Pesticides were applied following applicable campus, local and federal regulations.

2.15 Endangered Species Act

In 1997, an ecological scoping assessment was conducted to support the related *Draft Final Determination of Risk-Based Action Standards for DOE Areas* (DOE, 1997b). The Ecological Scoping Assessment (WA, 1997b) identified special status species that have a high potential to exist in or near Putah Creek, including two plant species, five invertebrates, nineteen birds, two reptiles, one amphibian and four mammals. These species and other potential receptors of concern are discussed in more detail in the Ecological Scoping Assessment. These species are considered during planning of remedial activities, so that any potential impact to them is eliminated or mitigated.

Habitat for the Valley Elderberry Longhorn Beetle (Beetle), a threatened species under the Endangered Species Act, has been identified at the Site, as discussed in Section 1.4 of this report. During the development of the EE/CA for the Western and Eastern Dog Pens, a potential disturbance of the Beetle habitat was identified and a mitigation plan was developed to prevent any impact to the species. The plan was submitted to and approved by the US Fish and Wildlife Service.

2.16 National Historic Preservation Act

All areas affected by current remediation activities involve existing structures located on previously graded and developed land. An archeological evaluation was conducted during the Phase II Soil and Ground Water Characterization of the Site (DOE, 1992a). No evidence of cultural resources, or historical or agriculturally sensitive areas was encountered. Prior to beginning work at the Site, the State Historic Preservation Officer is contacted to confirm findings of no effect on historic resources as required by Section 106 of the National Historic Preservation Act of 1996.

2.17 Executive Order 11988, "Floodplain Management" and Executive Order 11990, "Protection of Wetlands"

The Site is not on a floodplain, nor is any portion of it designated as a wetland.

2.18 Other Major Environmental Issues and Actions

2.18.1 Radium/Strontium Treatment System Removal Action

In 2000, a non-time-critical RA was conducted at Ra/Sr Treatment System Area II. The RA was implemented in accordance with the National Contingency Plan (NCP) 40 CFR Part 300.415.

The Ra-226 and Sr-90 Treatment Systems are located between Animal Hospital Nos. 1 and 2 (Buildings AH-1 and AH-2) in the western portion of the LEHR facility and together comprise the Ra/Sr Treatment Systems Area (Figure 1-2). These systems were used to treat radioactive liquid wastes generated from the animal experiments.

The Ra-226 Treatment System received low-level radioactive waste, including fecal material and washdown water from AH-2. The system consisted of two septic tanks, each containing multiple compartments separated by weirs, a distribution box, three dry wells and two leach trenches and associated distribution pipelines. Solids settled out in the septic tanks and fluids were pumped from the tanks and fed through the distribution box to one of the three vertical dry wells or the leach trench.

The Sr-90 (Imhoff) Treatment System received low-level radioactive waste from Sr-90 experiments. Effluent was processed through the Imhoff Treatment System and then was discharged to two leach fields. The Imhoff Treatment System consisted of a series of nine tanks, and primarily used sedimentation, aeration, chemical clarification and filtration to treat the waste. The remaining waste was then passed through a cation exchange resin and discharged to the Sr-90 leach fields.

The Ra/Sr Treatment System Area has been divided into two areas for the RA. Area I consists of Domestic Septic Tank Number 2, the distribution box, piping, three drywells and the northern and southern leach trenches. The Area I RA was completed in 1999. Area II consists of the Ra-226 Tanks, Sr-90 Tanks, the Sr-90 Tank Leach Field and the influent tank piping. The Area II RA was completed in 2000.

The objectives of the Area II RA conducted in 2000 were defined in the EE/CA (WA, 1998b) as follows:

- Lower the excess cumulative cancer risk to an individual from exposure to site contaminants to a nominal range of 10^{-4} to 10^{-6}, using 10^{-6} as the point of departure;
- Reduce the non-cancer hazard index below 1;
- Mitigate potential future impact to ground water;
- Mitigate potential ecological risks during and after the RA; and,
- Minimize impact to on-site University research.

The RA was conducted in accordance with the *Final Work Plan for the Removal Action at Southwest Trenches, Ra/Sr Treatment Systems, and Domestic Septic System Areas* (WA, 2000b). Area II RA activities began in July 2000 and were completed in November 2000.

The Area II RA was implemented in two phases. The Sr-90 leachfield and influent piping associated with both the Ra-226 and Sr-90 tanks were removed during the first phase of the RA (Figure 4-2). A total of 300 cu yds of waste was removed and packaged for off-site disposal during Phase I of the excavation. The second phase of the Area II RA consisted of excavating and removing the Ra-226 and Sr-90 tanks. A total of 1,200 cu yds of waste was removed and packaged for off-site disposal during Phase II of the excavation. Following the removal of these subsurface structures and the surrounding contaminated soil, confirmation samples were collected, followed by backfill and compaction of the excavations. Approximately 1,800 cu yds of soil were required for backfilling. An off-site source of clean backfill soil was identified, tested and deemed appropriate for use on site. Excavations were backfilled and compacted in accordance with the work plan requirements.

2.18.2 Waste Disposal

Approximately 351 cu yds of IDW and waste generated during the 1998 Southwest Trenches Area and the Ra/Sr Treatment Systems Area I RA were disposed in 2000. All the waste was characterized as low-level radioactive waste and was disposed at Envirocare of Utah.

2.19 Summary of Permits

There were no permit violations involving Site operations in 2000. The following permits are related to operations at LEHR:

- ***NPDES Permit #CA0077895 (EPA) and WDR Order No. 92-040 (CVRWQCB):*** UC Davis permits for discharge of wastewater from the UC Davis Wastewater Treatment Plant to the south fork of Putah Creek.
- ***EPA RCRA Interim Status (CAD982469702):*** Part A Permit application for storage of mixed waste. This permit is no longer needed since DTSC approved closure of the mixed waste storage facility in March 2000. Therefore, a request to EPA to rescind the Interim Status was made in April 2000 and, we are awaiting EPA's response.

Table 2-1. Compliance with Hazardous Material Reporting Under the Emergency Planning and Community Right to Know Act

EPCRA 302-303: Planning Notification	[ ] Yes	[ ] No	[x] Not Required
EPCRA 304: EHS Release Notification	[ ] Yes	[ ] No	[x] Not Required
EPCRA 311-312: MSDS/Chemical Inventory	[x] Yes	[ ] No	[ ] Not Required
EPCRA 313: TRI Reporting	[ ] Yes	[ ] No	[x] Not Required

Abbreviations

EHS	Extremely Hazardous Substances
EPCRA	Emergency Planning and Community Right to Know Act
MSDS	Material Safety Data Sheet
TRI	Toxic Release Inventory

3. ENVIRONMENTAL PROGRAM INFORMATION

Each year DOE monitors the environment at the Site via air, water, and soil sampling conducted by DOE and UC Davis. This section describes the LEHR environmental monitoring program, and summarizes 2000 environmental monitoring activities. The results of this monitoring program are discussed in Sections 4, 5 and 6.

3.1 Summary of Environmental Protection Program

The environmental protection program at LEHR consists of ongoing programs that include compliance monitoring and any other relevant environmental protection requirements. Overall program requirements are defined in DOE Order 5400.1, as well as in applicable federal, state and local environmental regulations. This program consists of, but is not limited to, those actions needed for compliance in the following areas:

- RAs and other activities involving cleanup of past actions under CERCLA;
- Ground water, surface water, soil, sediment, air and biota monitoring described in the *Revised Field Sampling Plan* (Dames & Moore, 1998);
- Documentation under NEPA;
- Reports to DOE, including this ASER and other reports required by DOE Orders;
- Hazardous waste management, including waste minimization, storage, segregation, characterization, designation and disposal;
- Hazardous materials inventory and usage and other reports and information as requested or required by regulatory agencies; and,
- EPA permit requirements for storage of mixed waste if it is found during CERCLA activities.

3.2 Notification of Environmental Occurrences and Reporting

Requirements for notification and reporting environmental occurrences are defined in DOE Orders and/or in the regulations governing release of hazardous materials. Environmental monitoring personnel have been instructed to notify appropriate management personnel if monitoring data indicate that hazardous material has been released above reportable quantities.

The DOE LEHR Project Manager is responsible for reporting environmental occurrences under DOE Orders 5484.1 and 232.1-1. The reports are transmitted to the DOE System Safety and

Development Center and DOE Headquarters. The Occurrence Reporting and Processing System is utilized in this process. No reports were filed in 2000.

3.3 General Planning and Reporting

In addition to this ASER, general planning and reporting for the Site environmental management program is facilitated through documentation prepared by WA, the DOE prime contractor. This ensures comprehensiveness of the environmental monitoring program at LEHR.

3.4 Environmental Monitoring Programs

The LEHR ER/WM Project conducts environmental monitoring according to permit and regulatory requirements to establish background information and to monitor operations related to Site restoration activities. The WA Project Manager is responsible for the oversight of these programs, and ensures that plans are reviewed and updated as required by DOE Orders.

3.5 Summary of 2000 Environmental Monitoring

3.5.1 Environmental Monitoring and Surveillance Plan

The environmental monitoring program for the LEHR ER/WM Project is described in the *Environmental Monitoring and Surveillance Plan* (DOE, 1992b and WA, 1997c) developed in accordance with DOE Order 5400.1. These plans provide guidelines for the measurement and documentation of environmental releases, should they occur. Data are evaluated to determine the effects of DOE operations at LEHR on the environment, both on site and off site. The program supports environmental compliance requirements and promotes goals of the Site environmental management policy. Because RAs at the Site are being conducted under CERCLA, water, soil, and biota are being investigated within the streamlined CERCLA process as discussed in the following sections.

3.5.2 Effluent Monitoring

Storm water runoff and airborne emissions during D&D and RA activities are the only effluent streams monitored by the Site Environmental Monitoring and Surveillance Program. Active liquid effluent discharges to the environment were curtailed in the 1980s at the end of LEHR research activities. There are now no active radiological or hazardous liquid effluent discharges to the environment from DOE-sponsored activities at the Site. An analysis of potential airborne effluent sources (leach field, chemical dispensing areas, dog pen soils, Imhoff D&D, etc.) determined that non-point diffuse area sources at the Site would generate an EDE below 7.52×10^{-4} mrem/yr, well below the 10 mrem/yr NESHAP standard.

3.5.3 Ambient Radiation Monitoring

Passive thermoluminescent dosimeters (TLDs) are used to monitor gamma radiation at LEHR. TLDs are placed near perimeter fence lines, radioactive waste storage areas and various work areas around the Site. The TLDs are collected quarterly, and an annual gamma radiation dose is calculated for each location. The TLD data are normalized for each quarter by subtracting Site background activity from each location. The results of the ambient radiation monitoring program are discussed in Section 4.

3.5.4 Surface and Ground Water Monitoring

The Revised Field Sampling Plan (Dames & Moore, 1998) has been developed in accordance with CERCLA as well as applicable state and federal regulations. Water monitoring is conducted by UC Davis and DOE as part of the Site Environmental Restoration Program.

Monitoring points have been identified to evaluate water quality and the lateral and vertical extent of environmental impacts to the Site. The program is guided by data needs for risk analysis and evaluation of Site remediation alternatives. The scope of the program is modified when required to meet objectives (as approved by regulatory oversight agencies) of the CERCLA process and environmental restoration activities progress. This also provides the flexibility necessary to obtain temporal and spatial information regarding chemical and radiological constituents.

In 2000, UC Davis performed all ground water and surface water monitoring, and monitored storm water runoff from the UC Davis areas of the Site. DOE monitored storm water runoff from the DOE areas only. The surface water monitoring results are discussed in Sections 4 and 5, and ground water monitoring results are discussed in Section 6.

3.5.5 Air Monitoring

Pacific Northwest National Laboratory (PNNL) conducted a CERCLA one-year baseline air monitoring program at the Site in August 1995. Data collected from the Site included both radiological and non-radiological parameters for substances previously detected in soil, ground water, and surface water at the Site. Air monitoring locations were based on historical records of site activities, planned investigation activities and soil and water monitoring data.

On January 1, 1997, WA assumed responsibility for the air monitoring activity at the Site. The air monitoring program in 2000 included monitoring during the Ra/Sr Treatment System RA.

3.6 Site Environmental Training

Site-specific environmental training has been conducted to instruct environmental restoration project personnel on pollution prevention, waste minimization and procedures to ensure that environmental controls are adequately maintained during remediation activities. This training is

conducted as part of the Site orientation training, and prior to any new activity, such as RAs, which could potentially impact the environment. Daily safety meetings reinforce this training and specify the steps needed to assure adequate environmental protection during that day's activities.

Before a worker is allowed to begin hazardous site work, he or she must complete the 40-hour Occupational Safety and Health Administration "Hazardous Waste Operations Training." In addition, prior to working on site, pollution prevention information is provided within the site-specific "Hazard Communication Training." This training ensures that the worker is aware of proper handling, usage and disposal of chemicals used on the job. It also covers spill prevention and control as well as proper storage and chemical disposal methods. Workers are also trained in radiological control methods to prevent the spread of radioactive contamination to the environment.

3.7 Waste Minimization and Pollution Prevention

The LEHR waste management program is committed to minimizing waste volumes by giving preference to source reduction, material substitution, decontamination, and recycling. Applicable waste minimization activities include:

- Avoiding the use of porous materials that cannot be decontaminated;
- Minimizing personal protective equipment waste through effective planning;
- Using real-time analyses to delineate the extent of contamination;
- Optimizing waste container utilization and recycling;
- Removing surface contamination from subsurface structures and pipes; and,
- Re-using uncontaminated soil and materials on site.

A detailed description of the LEHR Waste Minimization Program is located in Section 7 of the *Waste Management Annual Report for Fiscal Year (FY) 1997 and Waste Management Plan* (WA, 1998a). Also, waste minimization and pollution prevention are addressed in each work plan developed for activities that generate waste.

4. ENVIRONMENTAL RADIOLOGICAL PROGRAM INFORMATION

DOE activities at the Site in 2000 primarily consisted of the Ra/Sr Treatment Systems Area II RA, a field instrument pilot study in the WDPs and Site air and ambient radiation monitoring. Storm water monitoring was performed by both DOE and UC Davis for their respective areas. Surface water, ground water monitoring, and off-site neighbor well sampling were performed by UC Davis.

Data collection and site monitoring programs for DOE areas are conducted under the guidance of the Site Environmental Monitoring and Surveillance Plan (DOE, 1992b), and comply with CERCLA requirements. This section summarizes significant results and trends in radiological site air, soil, and water monitoring data for 2000. More detailed discussions of investigations and findings are presented in the reports referenced in each section.

The majority of radionuclide results for Site samples are close to or below the minimum detectable activity (MDA) for the laboratory analysis methods.

4.1 Radiological Air Monitoring

4.1.1 Site Baseline Air Sampling

Atmospheric releases of pollutants from the Site are a potential source of human exposure. Therefore, radioactive and non-radioactive materials in air have been monitored at a number of locations on and around the Site since August 1995. The locations of the current air monitoring stations are shown in Figure 4-1.

The influence of LEHR emissions on local air pollutant concentrations is evaluated by comparing air concentrations measured at a background location to concentrations measured at the Site.

A one-year baseline air sampling investigation was conducted between August 1995 and August 1996. The analytical results of the one-year baseline air sampling investigation were presented in PNNL's Baseline Air Monitoring Report (Patton, 1996). WA continued several elements of the monitoring program through 2000 to provide additional baseline radiological data.

In February 1999, WA revised the existing air monitoring program. The revised program is based on the results of the air sampling investigation and sampling requirements outlined in DOE Orders 5400.1 and 5400.5 and DOE/EH-0173T – *Environmental Regulatory Guide for Radiological Effluent Monitoring and Environmental Surveillance* (DOE, 1991). The revised program includes:

- Monthly monitoring at four stations (AM-2, AM-5 and AM-7 and background station AM-3 [Figure 4-1]) for alpha and beta activities (monitoring was performed before, during and after RAs);
- Quarterly radon sampling of the three on-site stations and the background station; and,
- Continued collection of meteorological data at the on-site meteorological station.

The revised air monitoring program includes analyzing for Ra-226, Sr-90, and gamma emitters, and reduced sampling for tritium and non-radiological compounds (chlordane, respirable particulate matter (less than 10 microns) [PM-10], metals, volatile organic compounds [VOCs]). The approach for monitoring radionuclides in air includes continuous air monitoring for particle-associated radionuclides and for radon. Radionuclides to be analyzed in air samples were selected on the basis of: (1) their detection in site soil or ground water in above-background activities; (2) past site history and use; and (3) their relative importance in terms of potential dose to man and the environment.

The revised monitoring program calls for radon sampling at four air monitoring station locations using passive alpha-track air sampling cartridges. The air sampling cartridges are identical to those used for sampling residential radon activities. The cartridges are exchanged quarterly.

Air sampling was performed at the Site during the 2000 Ra/Sr Treatment Systems Area II RA to monitor potential elevated releases of radionuclides into ambient air. Samples for gross alpha and gross beta were collected before and after the RA. Radon sampling was not conducted in 2000.

4.1.2 Radiological Results for the Air Monitoring Program

No increased activities were detected during the 2000 Ra/Sr Treatment Systems Area II RA. The activities of all COCs detected at air monitoring station AM-7 (near Ra/Sr Area I) were similar to levels detected at background station AM-3.

Both the average and maximum activities of total alpha radiation collected at site perimeter locations during 2000 were similar or less than the background location, indicating that the observed levels were from natural sources and worldwide fallout. The 2000 average air activity for the site locations was 1.2×10^{-3} picoCuries per cubic meter (pCi/m^3), which was not statistically different from the average activity at the distant location (3.3×10^{-3} pCi/m^3). In addition, the highest 2000 gross alpha air activity for all air monitoring stations was at AM-3 (1.2×10^{-3} pCi/m^3). The highest 2000 gross beta radiation activity in ambient air was at AM-2 (7.3×10^{-3} pCi/m^3).

Sixteen air samples collected during 2000 were analyzed for gamma-emitting radionuclides. All gamma-emitting radionuclides were well below the DOE Derived Concentration Guidelines (DCGs) specified in DOE Order 5400.5, "Radiation Protection of the Public and the Environment." The DCG values represent the activity of a radionuclide in air that an individual could continuously inhale at average annual rates without receiving an EDE of greater than 100 mrem/yr.

4.1.3 National Emission Standards for Hazardous Air Pollutants Dose Estimation Calculations

Calculations were performed to determine the estimated dose from Site sources to the public. These calculations were based on site residual surface soil contamination (diffuse area sources) and maximum radionuclide activities generated from the Area II excavated wastes in 2000. RA work during the summer of 2000 did not cause any elevated fugitive dust emissions. The other potential area sources of emissions at the Site during 2000 were re-entrainment and subsequent dispersion of surface soil dust containing potentially elevated concentrations of radionuclides. Estimated contributions to the annual site EDE from non-point source emissions (surface soil) are shown in Table 4-1, and are well below the NESHAP limit.

The potential site non-point or diffuse sources (areas with known or potential radionuclide contamination resulting from past DOE activities at the Site) include the Ra/Sr Treatment Systems Area, the Southwest Trenches Area, the EDPs and WDPs Area, inactive landfill units and the storm water runoff system. Of these non-point sources, three were determined to have radioactive material in near-surface soil (0 to 3 ft bgs) that could potentially be a source of airborne radioactive material emissions. Those sources are the Ra/Sr Treatment Systems Area, the EDPs and the WDPs. Emission estimates from these sources are discussed below.

Compliance with the NESHAP requirements for diffuse, non-point source emissions was assessed using the EPA-approved DOE atmospheric dispersion/radiation dose calculation computer code, CAP88-PC, Version 1.0. Conservative radionuclide emission rates were estimated using maximum soil activities measured above background for the Ra/Sr Treatment Systems Area, and the WDPs and EDPs Areas as fugitive area sources. The emission rates were calculated by using the maximum radionuclide activities from the excavated wastes, assumes the wastes were exposed to the atmosphere for up to several weeks during the RA. These dust emissions rates were used to calculate the total estimated contribution to the EDE. The total contribution was estimated to be 7.52×10^{-4} mrem/year (Table 4-2). The CAP88-PC computer code was then used to calculate the EDE to individual receptors at various distances and from each of the four potential LEHR facility radionuclide emission sources. The estimated EDE to a maximally exposed individual (MEI) at the LEHR facility was determined by summing the contributions from all three potential LEHR facility radionuclide emission sources. Based upon the combined source exposures, the MEI assumed for the LEHR facility would be located on site in the Reproductive Biology Laboratory. The results of the assessment are shown in Table 4-2.

The CAP88-PC computer code was also used to calculate the collective population dose, as required by DOE Order 5400.5. The maximum off-site receptor exposure is estimated to be 8.65×10^{-6} mrem/yr, significantly below the 10 mrem/yr NESHAP standard (Table 4-3).

4.2 Radiological Soil Measurements

This section summarizes 2000 field activities and important soil analytical results for radiological compounds for the DOE areas at the Site. Results for non-radiological compounds are discussed in Section 5.

Soil sampling in support of the ongoing CERCLA remediation was performed in the Ra/Sr Treatment System Area in 2000. Soil samples were shipped to a contract laboratory for the requested suite of analyses. Full descriptions of the soil sampling methods, procedures for sample preparation and shipment, requested analyses and MDA limits, along with the associated quality assurance/quality control (QA/QC) requirements, are contained in the relevant work plans and reports.

Soil confirmation sampling was conducted as part of the Ra/Sr Treatment Systems Area II RA to guide the excavation, characterize the waste and determine whether RA objectives had been achieved. Results of the Ra/Sr Treatment Systems RA sampling will be presented in the draft Ra/Sr Treatment Systems Confirmation Report to be completed in September 2001.

4.2.1 Radium/Strontium Treatment System Removal Action—Confirmation Sampling

As discussed in Section 2, a non-time-critical RA was conducted at the Ra/Sr Treatment System Area II in 2000 (Figure 4-2). The RA was implemented in accordance with the NCP 40 CFR Part 300.415.

A total of 33 primary and 4 duplicate confirmation soil samples were collected between 1.5 and 12 ft bgs from the excavation sidewalls and floor. The objective of the confirmation sampling was to ensure the attainment of cleanup goals using a statistically-based sampling design. The grid size and statistical approach used to determine the required number of confirmation samples were consistent with EPA guidance (EPA, 1994). The draft Ra/Sr Treatment System Area II excavation confirmation samples were analyzed for the full suite of radionuclide COCs.

A preliminary data evaluation was conducted and presented to the LEHR RPMs on October 24, 2000. The preliminary analysis of excavation screening samples indicated that all residual concentrations in nearly all samples were at or near background and/or Risk-Based Action Standard (RBAS) levels. A detailed discussion of the confirmation sampling will be included in the Draft Ra/Sr Treatment Systems Confirmation Report to be completed in September 2001.

4.3 Radiological Surface and Storm Water Monitoring

Quarterly ground water and surface water sampling has been conducted at the Site since 1990 for an extensive list of analytes. In 1997, in accordance with the MOA, responsibility for surface water and ground water sampling was transferred to UC Davis. DOE retained responsibility for storm water runoff sampling in the DOE areas of the Site. Trends and conclusions drawn from the surface and storm water monitoring results are briefly discussed below. A detailed discussion of results and tables summarizing the analytic data can be found in the *2000 Annual Groundwater Treatment System and Water Monitoring Report* (Dames & Moore, 2001).

4.3.1 Surface Water Monitoring

In 2000, UC Davis collected surface water samples from four locations: Putah Creek Upstream (PCU), Wastewater (Sewage) Treatment Plant Outfall (STPO), Putah Creek Downstream (PCD) and PC2 located approximately 2 miles downstream of PCD (Figure 1-3). Samples were collected during two sampling events in the winter (January) and fall (October). During the winter sampling event, carbon-14 (C-14) was detected at PCD 60.9 ± 10.2 pCi/L. Previous C-14 results in samples collected at PCD during the past three years have all been non-detect(Dames and Moore, 2001). The only other radionuclide detected above the Contract Required Detection Limit (CRDL) was Ra-226 at 1.22 ±0.591 pCi/L, only slightly above the 1.0 pCi/L CRDL at PCU in October.

4.3.2 Storm Water Monitoring

Storm water samples are usually collected twice a year; once near the beginning of the rainy season after the first storm of the season and once near the end of the season. In accordance with the MOA between DOE and UC Davis (DOE, 1997a), DOE collected storm water from the lift station located on the western border of the Site (LS-1 in Figure 1-3) and UC Davis collected samples from the UC Davis areas of the Site (LF-1 and LF-3 in Figure 1-3).

Storm water samples were collected in January and October 2000. The January sample represents the second sample for the 1999/2000 rainy season and the October sample represents the first sample for the 2000/2001 rainy season. All radiological constituents were below their respective CRDLs with the following exceptions. In January, C-14 was detected at 26.5 ±9.3 pCi/L at LF-1, above the 20 pCi/L CRDL for this analyte. At LS-1 in January, tritium was detected at 568 ±319 pCi/L (CRDL = 300 pCi/L). At LS-1 in October, gross beta was detected at 6.11 ±1.37 pCi/L (CRDL = 3.0 pCi/L). An occasional detection of C-14 or gross beta is consistent with historical data. Tritium has not been previously detected above the CRDL in storm water samples, and therefore the January 2000 result may be anomalous (Dames and Moore, 2001).

4.4 Passive Thermoluminescent Dosimeter Monitoring Program

The LEHR ambient radiation monitoring program uses TLDs to monitor gamma radiation throughout the Site. The TLDs are placed near perimeter fence lines, radioactive waste storage areas and various work areas around the Site (Figure 4-3). The TLDs are collected quarterly, and an annual gamma radiation dose is calculated for each location. In 2000, TLDs and analyses were provided by Radiation Detection Company, which is certified by the National Voluntary Laboratory Accreditation Program. TLD-35, located at the equine center to the north of the Site, is used to monitor background activity. TLD-29 was located on a temporary boundary fence that restricted access into the RA area. TLD-29 was removed once the RA was completed and the fence was removed.

The annual background dose near the Site (measured by TLD-35) is 81 mrem/yr which is consistent with previous years. The annual dose at the Site exceeded the background at only one location, TLD-14, where the dose was 90 mrem/yr. In December 1999, TLD-14 was moved

approximately 14 ft east of its original location at the entrance to Geriatrics I to a location near the DOE sources stored in Geriatrics I. The DOE public dose limit for exposure of members of the public as a consequence of routine DOE activities is 100 mrem/yr. Year 2000 TLD results show that ambient radiation detected at the Site is not generally elevated with respect to off-site background, and is well below the DOE dose limit for the general public.

Table 4-1. Estimated Annual Maximum Effective Dose Equivalent

Maximum Individual Dose[1]	EPA and DOE Standard
7.52×10^{-4} mrem/year (7.52×10^{-6} mSv/year)	10 mrem/year (0.1 mSv/year)

Notes

[1]Maximum effective dose equivalent from Calendar Year 2000 Radionuclide Air Emission Annual Report (to be submitted in the Fall 2001). Data are calculated, not measured, therefore, they represent potential or estimated rather than actual doses.

1 Sievert (Sv) = 100 Roentgen Equivalent Man (rem)

Abbreviations

DOE	U.S. Department of Energy
EPA	U.S. Environmental Protection Agency
mrem/year	millirem per year
mSv/year	milliSievert per year

Table 4-2. Estimated Dose Equivalent to On-Site Maximally Exposed Individual from Site Non-Point/Diffuse Sources

Nonpoint Source	Dose Equivalent[1]
Ra/Sr Treatment Systems Area	6.8×10^{-4} mrem/yr
Western Dog Pens Area	7.10×10^{-5} mrem/yr
Eastern Dog Pens Area	9.50×10^{-7} mrem/yr
Total Combined Contribution	7.52×10^{-4} mrem/yr

Notes
[1]Maximum EDE from Calendar Year 2000 Radionuclide Air Emission Annual Report (to be submitted in Fall 2001). Data are calculated, not measured, therefore, they represent potential or estimated rather than actual doses.

Abbreviations

mrem/yr	millirems per year
Ra/Sr	Radium/Strontium

Table 4-3. Summary of Estimated Off-Site Collective Population Dose Resulting from Radionuclide Emissions from Each Fugitive Dust Emission Source

Location	Off-Site Maximally Exposed Individual (mrem/yr)[1]	Off-Site Maximally Exposed Individual Distance[2]	Collective Population Dose (person-rem/yr)
Ra/Sr Treatment Systems Area	1.60E-06	250 m North[1]	4.90E-06
Western Dog Pens Area	6.48E-06	250 m North[1]	1.97E-05
Eastern Dog Pens Area	5.74E-07	250 m North[1]	1.72E-06
Total Site	**8.65E-06**		**2.63E-05**

Notes
[1]Maximum off-site effective dose equivalent from Calendar Year 2000 Radionuclide Air Emission Annual Report (to be submitted in Fall 2001). Data are calculated, not measured, therefore, they represent potential or estimated rather than actual doses.

[2]Distance and direction from source area center to maximally exposed individual receptor location.

Abbreviations

mrem/yr	millirems per year
Ra/Sr	Radium/Strontium
rem/yr	rems per year

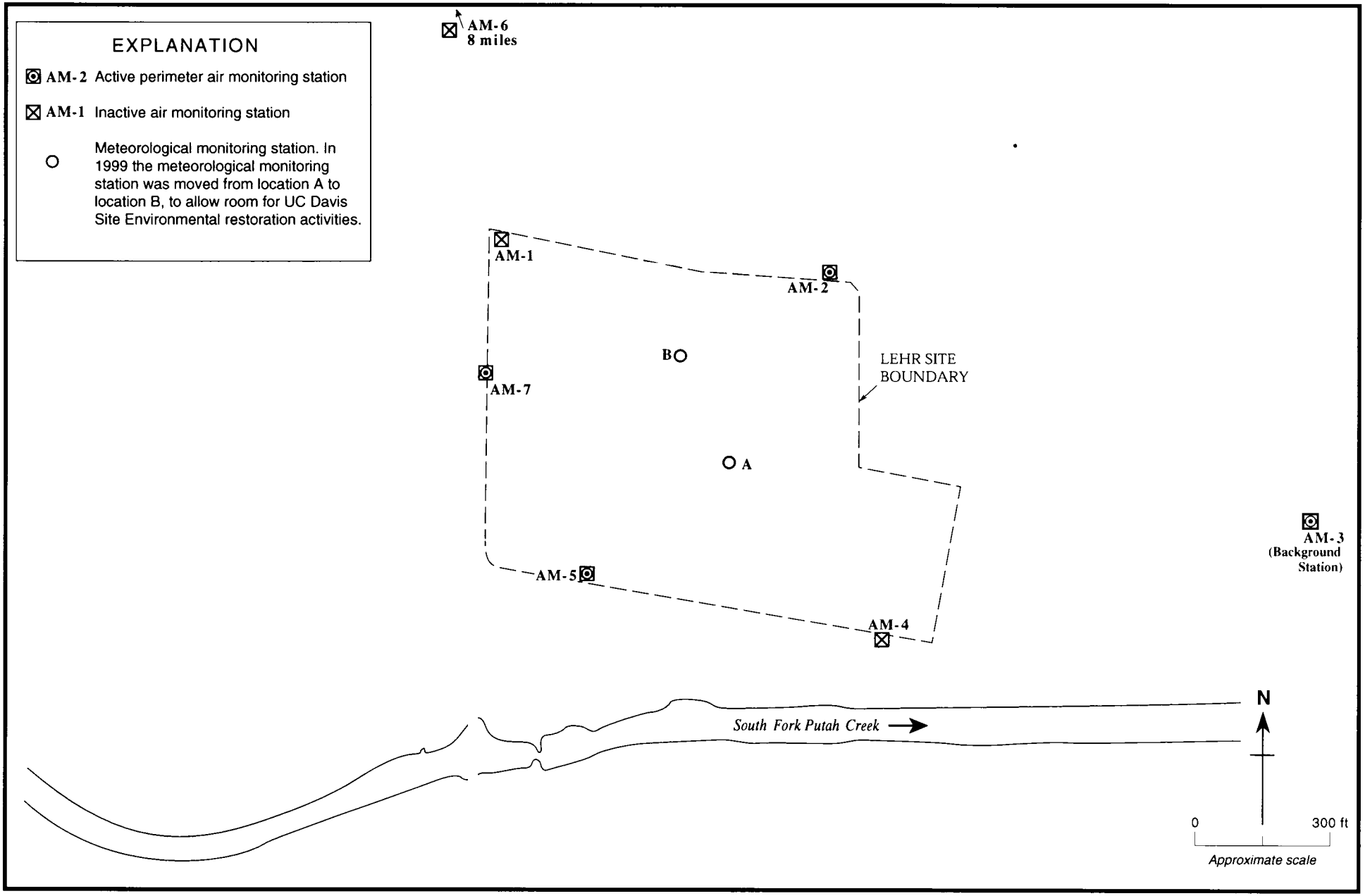

Figure 4-1. Site Air Monitoring Station Locations, LEHR Site, UC Davis, California

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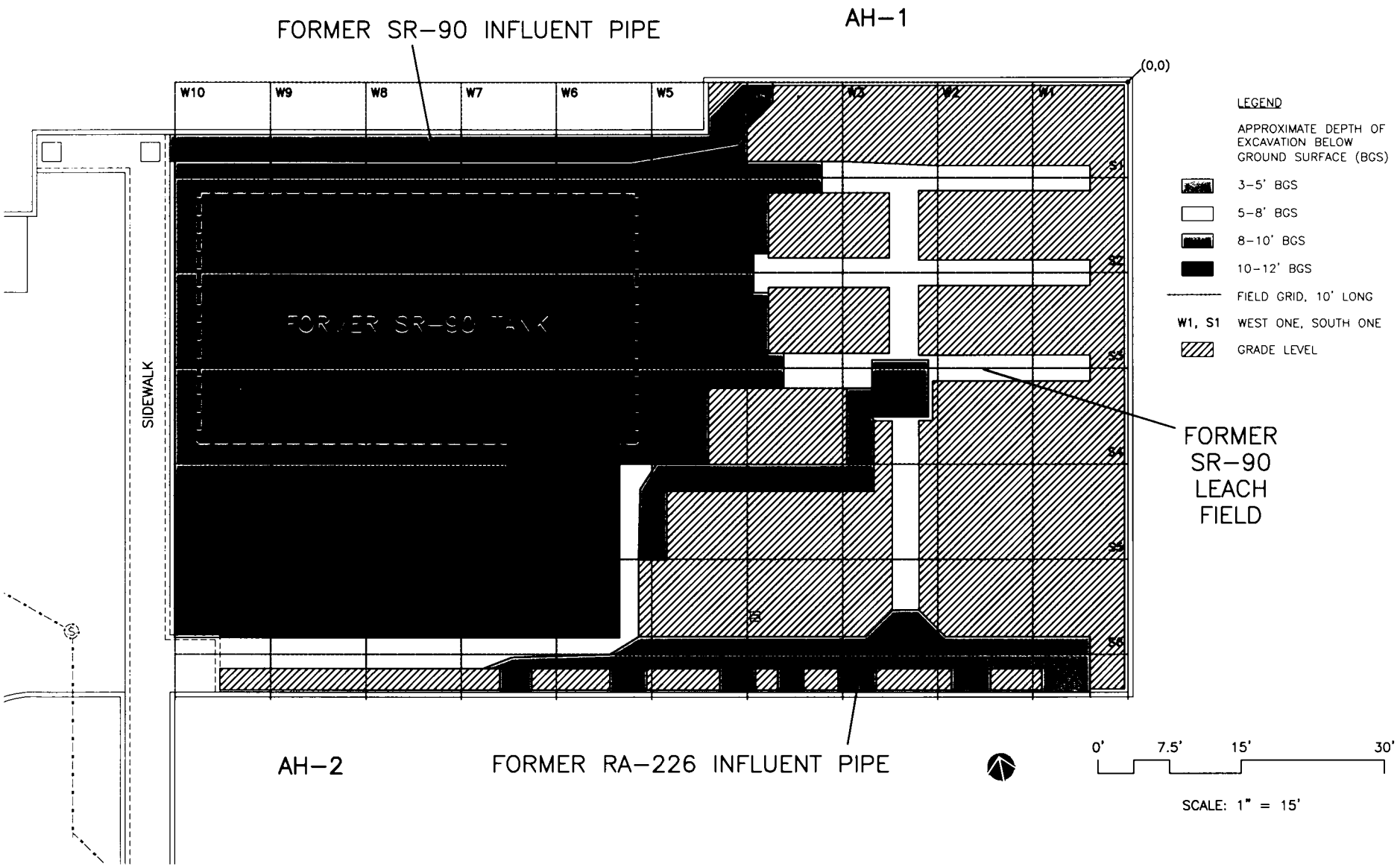

Figure 4-2. Ra/Sr Area II, Removal Action

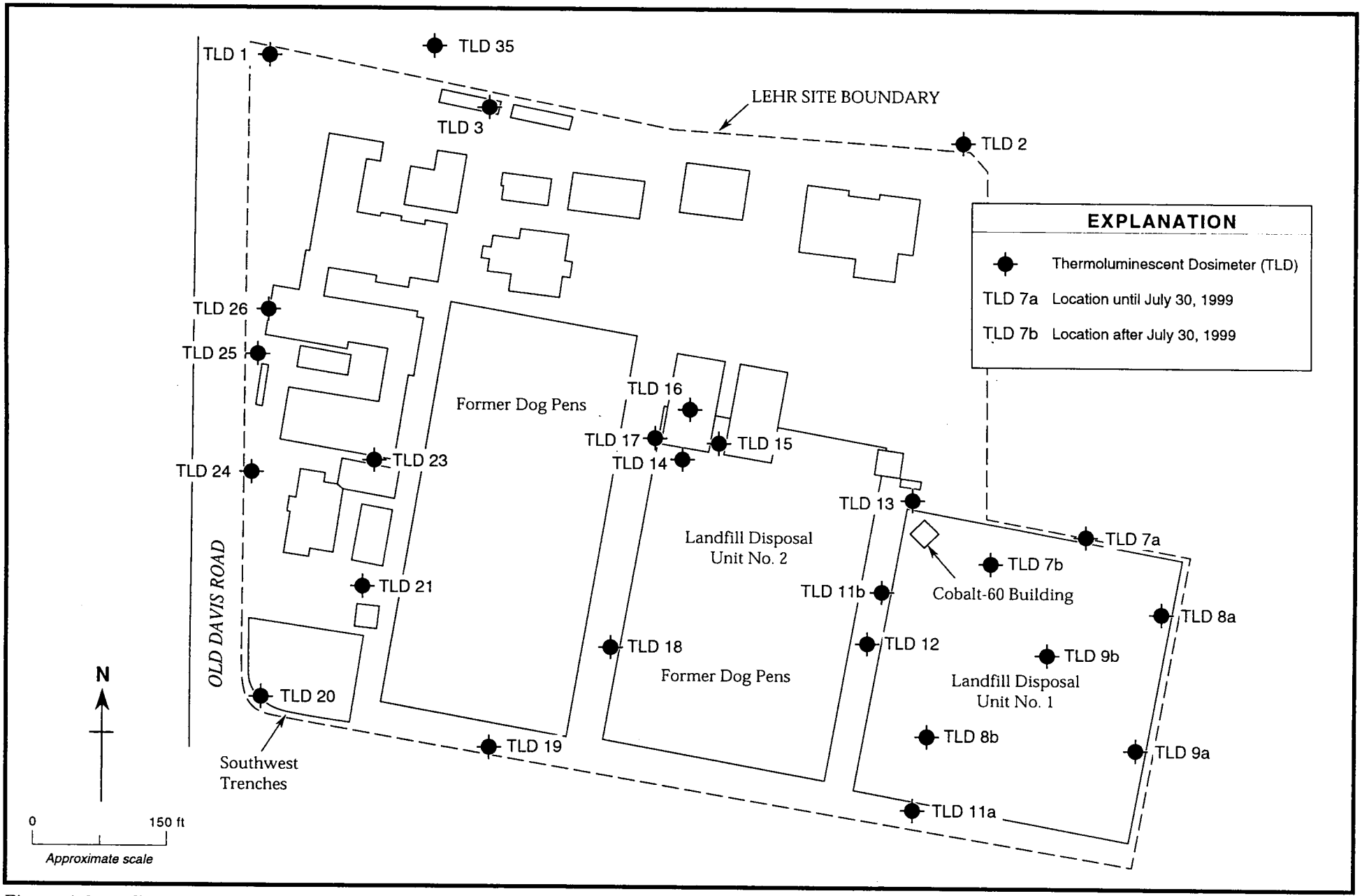

Figure 4-3. Thermoluminescent Dosimeter Location Map, LEHR Site, UC Davis, California

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5. ENVIRONMENTAL NON-RADIOLOGICAL PROGRAM INFORMATION

This section briefly summarizes significant results and trends in 2000 non-radiological site air, soil and water monitoring. More detailed discussions of investigations and findings are presented in the reports referenced in each section.

5.1 Non-Radiological Air Monitoring

Air monitoring for non-radiological compounds was performed to detect potential elevated releases of non-radiological compounds into ambient air resulting from the 2000 Area II RA. VOCs and PM-10 were sampled before the RA and PM-10 was sampled after the RA. The majority of air contaminants identified during 2000 were below the laboratory detection limits.

Preliminary review of the air analytical data indicates that the maximum VOC concentration detected was acetone at 10 parts per billion by volume. PM-10 results were between 0.001 grams (g) and 0.102 g, which is less than the 1999 PM-10 results . Details of non-radiological air compound monitoring will be included in the *LEHR Air Monitoring Report Summary for 1995-2000* to be submitted in the Fall of 2001, and the Ra/Sr Treatment Systems RA Confirmation Report, to be completed by September 2001.

5.2 Non-Radiological Soil Monitoring

As discussed in Sections 2 and 4, a non-time critical RA was performed at the Ra/Sr Treatment Systems Area II. As stated in Section 4.2.1, a preliminary review of the confirmation sampling results indicate that residual concentrations in nearly all samples were at or near background or RBAS levels.

5.3 Non-Radiological Surface and Storm Water Monitoring

In 2000, ground water and surface water sampling were conducted and reported by UC Davis. DOE sampled only storm water runoff from DOE areas at the Site. Trends and conclusions drawn from the surface and storm water monitoring results are discussed briefly below. A detailed discussion of results and tables summarizing the analytic data can be found in the *2000 Annual Groundwater Treatment System and Water Monitoring Report* (Dames & Moore, 2001).

5.3.1 Surface Water Monitoring

Surface water samples were collected twice in 2000 at locations PCU, STPO, PCD and PC2 (Figure 1-3). Location PC2 was sampled only for chronic aquatic toxicity in January 2000. Significant results include:

- Concentrations of chloroform and molybdenum were slightly elevated compared to upstream location PCU. Bromodichloromethane (9.4 µg/L) and ethyl ether (1.3 µg/L) were the only other VOCs reported in surface water samples in 2000. Metals detected above CRDLs in 2000 included barium, boron, copper, iron, manganese, vanadium, and zinc. Results for metals in surface water samples were within historical ranges with the exception of boron, which was added to the analyte list in 2000.
- Results for nitrate as nitrogen were within or slightly lower than historical ranges, and total dissolved solids (TDS) concentrations were also similar to historical results.
- No evidence of chronic toxicity was indicated in the analyses of site surface water samples. However, laboratory control population and procedure problems resulted in the rejection of the January 2000 toxicity data.

5.3.2 Storm Water Monitoring

Storm water samples were collected in January and October 2000. The January sample represents the beginning of the 1999/2000 rainy season, and the October sample represents the beginning of the 2000/2001 rainy season. Analytical results were similar to previous years. Significant results include:

- Chloroform was not reported above the CRDL in any storm water samples collected from the Site in 2000, nor in the previous three years.
- Detections of nitrate as nitrogen were all below 1.5 milligrams per liter (mg/L), TDS ranged from 21 mg/L to 280mg/L, and total and hexavalent chromium were detected at concentrations up to 19.2 µg/L and 23 µg/L, respectively. These results are consistent with historical trends.
- Arsenic, barium, copper, lead, manganese, nickel, vanadium, and zinc were detected in storm water samples below their respective primary maximum contaminant levels (MCLs). Antimony was detected at concentrations up to 22.6 mg/L in LS-1, exceeding the MCL of 6 mg/L. These concentrations are consistent with previous years. Aluminum was added to the LS-1 analyte list in 2000, and was detected at values ranging from 354 µg/L to 3160 µg/L. Results for barium in the samples collected from LF-1 and LS-1 in October 2000 were higher than previous results for this analyte (320 µg/L and 213 µg/L, respectively).

- Acetone, 2-butanone, and methylene chloride were detected in the samples from LS-1; however, the results were qualified (UJ) due to analytical laboratory calibration and method blank QC results.
- Aquatic toxicity results show no significant adverse effects.

5.3.3 National Pollutant Discharge Elimination System Data

The Site discharges its sanitary waste to the UC Davis Wastewater Treatment Plant according to NPDES permit requirements. Current DOE activities do not contribute to hazardous discharges.

6. GROUND WATER PROTECTION PROGRAM

Ground water monitoring has been conducted quarterly for the LEHR ER/WM Project since November 1990. The quarterly monitoring program began as a component of the *Phase II Site Characterization* (Dames & Moore 1993). In 1993, the program evolved to include the development of a site water monitoring plan designed to meet the requirements of DOE's GEPP in DOE Order 5400.1. In 1998, a ground water IRA was started by UC Davis. Water monitoring is conducted in conjunction with the CERCLA process as part of the DOE-sponsored environmental restoration program underway at the Site. Since the original research activities ceased in 1989, the current water monitoring program focuses primarily on environmental surveillance activities for non-operational facilities and monitoring of the UC Davis IRA. Figure 1-3 shows the location of LEHR ground water monitoring wells.

The objectives of the ground water monitoring program are to characterize baseline ground water conditions at the Site by: 1) further evaluating impacts of previous LEHR facility operations on ground water in the area; 2) providing data to support future site activities (risk assessment and remedial actions); 3) complying with applicable federal, state and local regulations, and; 4) evaluating the effectiveness and progress of the UC Davis IRA.

In 2000, all ground water and surface water monitoring at the Site was performed and reported by UC Davis, except for storm water sampling from DOE areas (Section 5). The results of the water monitoring are summarized briefly here, and are discussed in detail in the UC Davis Quarterly Water Monitoring Reports and the *2000 Annual Groundwater Treatment System and Water Monitoring Report* (Dames & Moore, 2001).

6.1 Uses of Ground Water in the LEHR Vicinity

Local ground water is utilized for both drinking and agricultural purposes. The major ground water sources for both public and private water supplies in the Sacramento Valley are unconsolidated deposits of Pliocene and Pleistocene age, and older alluvium (DOE, 1992b). Water from the first HSU is not used for drinking or irrigating purposes due to inadequate yield. In the Site vicinity, a number of domestic and irrigation wells produce water from HSU-2.

6.2 Potential Sources of Ground Water Pollution

A number of locations on site are considered "waste management areas," where a variety of potential wastes were handled and/or buried during former site operations. Impact from these areas has been evaluated during previous investigations and may be further evaluated during future investigations and/or remedial actions.

Most impacts to ground water that have been identified are localized on the Site near waste burial locations and are within the first HSU, which is not used for drinking water.

6.3 Ground Water Monitoring

In 1997, the MOA between DOE and UC Davis transferred responsibility for surface water and ground water sampling from DOE to UC Davis. The ground water monitoring program discussed in this section is the responsibility of UC Davis.

UC Davis collected a total of 213 samples (including 18 duplicate samples) from 30 site wells in 2000. The ground water monitoring program and the 2000 sampling results are summarized below and discussed in more detail in UC Davis' *2000 Annual Groundwater Treatment System and Water Monitoring Report* (Dames & Moore, 2001). Isoconcentration maps for 1997 through 2000 generated by Dames and Moore for HSU-1 and HSU-2 are included in Appendix A.

In 2000, the ground water monitoring program schedule and analyte list was revised, expanding on modifications made in 1999. Modifications initiated in 1999 were outlined in the *1998 Annual Water Monitoring Report* (Dames & Moore, 1999), and results were discussed in *1999 Annual Water Monitoring Report* (Dames & Moore 2000). Additional changes implemented in 2000 included adding metals and inorganic chemical analyses to samples collected from the treatment system effluent and several monitoring wells, modifications for a Land Treatment Pilot Study developed by Montgomery Watson in 2000, and a pilot test for a density-driven convection (DDC) system for enhanced source removal. Initiation of land treatment is planned for spring 2001, and a report on the effectiveness of the DDC system is scheduled for mid-2001 (Dames & Moore, 2001).

In May 2000, HSU-2 well UCD2-46 was installed in to evaluate chloroform concentrations near abandoned irrigation well 22N, and HSU-4 well UCD4-47 was installed adjacent to well 22N. Former irrigation well 22N was a suspected conduit for contaminant migration from HSU-2 into HSU-4.

6.3.1 Radionuclides

HSU-1: In 2000, HSU-1 wells were only monitored C-14 and tritium. C-14 and tritium were detected at maximum concentrations of 1,220 ±25 pCi/L and 12,500 ±318 pCi/L, respectively. Also concentrations continue to decrease in UCD1-13.

HSU-2: C-14 was detected in UCD2-14 at a maximum concentration of 575 ±16.8 pCi/L, which is consistent with historical data. Tritium was detected above the CRDL at a maximum activity of 3920 ±329 pCi/L in UCD2-14, consistent with previous years. Bismuth-214 (Bi-214), gross alpha, gross beta, lead-212, Ra-226, and plutonium-241 were detected at low levels above the CRDL, also consistent with previous years.

HSU-4: C-14 was reported at 44.1 ±6.43 pCi/L in one sample. Tritium was not detected above the CRDL in any samples. Bi-214, gross alpha, gross beta, lead-214, and Ra-226 were detected above the CRDL at low levels, which is consistent with previous years.

6.3.2 Non-Radionuclides

HSU-1: The maximum chloroform concentration detected in 2000 was 7,950 µg/L, and concentrations reported for HSU-1 monitoring wells in 2000 were within typical ranges for previous sampling events. Concentrations of nitrate, TDS, metals and general chemical parameters were detected at levels that are consistent with previous years (the TDS result for the September 2000 sample from well UCD1-18 was considered anomalous at 2,450 mg/L). Semi-volatile organic compounds (SVOCs), pesticides and polychlorinated biphenyls (PCBs) were not detected in HSU-1, which is consistent with previous years.

HSU-2: Chloroform concentrations in most HSU-2 wells are decreasing, indicating that the IRA treatment system is successfully containing the plume. Only well UCD2-29 reported VOCs other than chloroform. Concentrations of nitrate, TDS, metals and general chemical parameters were detected at levels that are consistent with previous years. SVOCs, pesticides, and PCBs were not detected in HSU-2, similar to previous years. Concentrations in the new HSU-2 wells (UCD2-45 was installed in November 1999 and UCD2-46 was installed in May 2000) ranged from 4.59 mg/L to 10.4 mg/L for nitrate, 523 mg/L to 717 mg/L for TDS, and 22.1 µg/L to 62.0 µg/L for chromium.

HSU-4: Concentrations of chloroform in HSU-4 monitoring wells are lower than concentrations reported before the abandonment of well 22N. No chloroform was detected in Well UCD4-44, upgradient of Well 22N, in 2000. Concentrations of nitrate, TDS, metals and general chemical parameters were detected at levels that are consistent with previous years. Concentrations in the new HSU-4 well (UCD4-47) ranged from 5.54 mg/L to 6.73 mg/L for nitrate, 392 mg/L to 549 mg/L for TDS, and 31.4 µg/L to 39.9 µg/L for chromium.

6.4 Off-Site Supply Well Sampling

Sampling of private wells south, north, and east of the Site has been conducted since 1989. Because these wells are not uniformly constructed, limited comparisons can be made between these wells and those on the LEHR Site. The off-site supply well sampling program has provided information about the primary Site COCs: VOCs, tritium, hexavalent chromium, nitrate as nitrogen, gross alpha and gross beta. Monitoring of radiological constituents in private wells was ceased in 1996 because no radiological contamination that could be attributed to the LEHR Site was found in any offsite supply well.

In 2000, UC Davis sampled irrigation and domestic wells east of the Site three times (winter, summer and fall) (Figure 6-1). Hexavalent chromium and nitrate as nitrogen were detected in many of the wells. These compounds are present in regional ground water, and no direct link to the Site has been established.

In 2000, the only VOCs detected in off-site private wells were chloroform and acetone. Chloroform was detected at 1.6 µg/L in the winter sample collected from off-site well, 22A, which is consistent with the historical data for this well. Acetone was detected at 6.2 µg/L in the summer sample collected from off-site well, MIW. Based on the last five years, this is the first time acetone has been detected in this well and acetone has only been detected twice during the last five years in any of the wells sampled in this program.

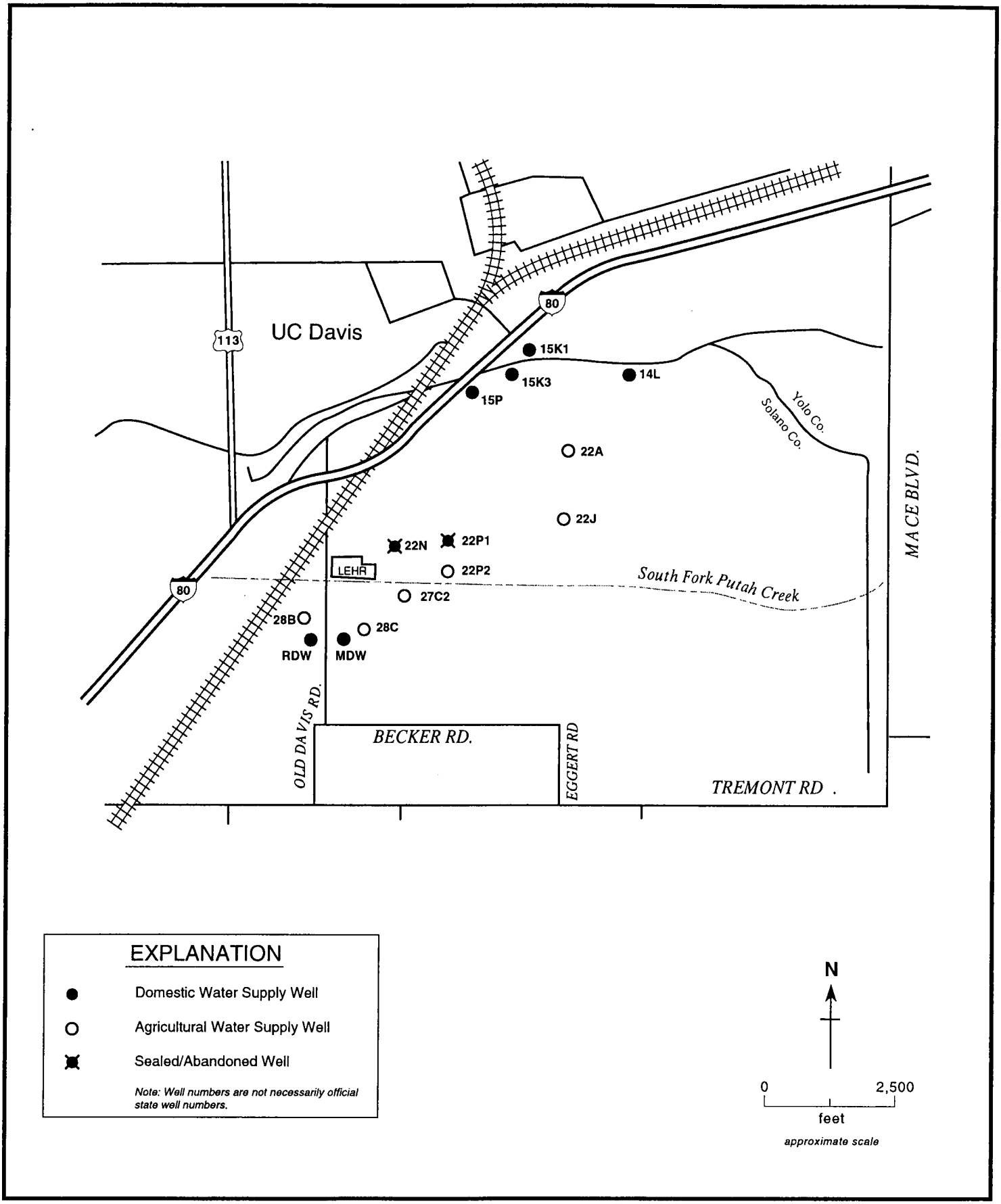

Figure 6-1. Neighbor Well Sampling Program Locations Near the LEHR Site, UC Davis, California

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7. QUALITY ASSURANCE

Quality assurance is a key element of the environmental protection program for the Site. A Quality Assurance Project Plan (QAPP) that describes the requirements for all quality-related work on the LEHR project has been prepared (WA, 2000c). In the planning for each phase of the LEHR ER/WM Project (site characterization, investigation, D&D, etc.) the QAPP and other quality-assuring documents such as Standard Quality Procedures, Standard Operating Procedures (SOPs) and task-specific work plans are prepared followed. The purpose of the QAPP and these other documents is to identify the specifications and methods employed to establish technical accuracy, precision and validity of measurements and statistics, and to provide a sound basis for management decisions that will be based on environmental information collected for the Site. The QAPP for the LEHR ER/WM Project was prepared in accordance with EPA QA/R-5 and National Quality Assurance specifications. It also incorporates guidance from DOE Order 414.4a, the Nuclear Safety Management Quality Assurance Requirements in 10 CFR 830.120 and the GEPP as defined in DOE Order 5400.1, to ensure that DOE quality and environmental goals are met.

Environmental samples collected by DOE that are discussed in this report were collected, analyzed, reviewed and validated according to the QAPP and other relevant SOPs and/or task-specific work plans. To assure quality, QC is integrated into all aspects of environmental sampling. Included in the QAPP and related documents are sections identifying QC for sample collection requirements and specific QA objectives for the measurement data. QC samples are run with each sample batch at the laboratory to validate the method of analysis and the proficiency of the analyst. Because holding times are an important factor in the sample quality, these are carefully controlled. To ensure the comparability of analytical data, all samples are analyzed by EPA-approved methods when available. When analytic results are received, they are reviewed according to the appropriate data quality objectives and data review procedures. All of the 2000 site air, soil, and water monitoring data have been, or will be, presented in separate reports. The specific review and validation process for each data set is presented in these reports, and will not be discussed in detail here.

7.1 Field Quality Assurance

Quality assurance for field sampling is accomplished by using field replicates, decontamination rinseates, trip blanks and field blanks, as appropriate for the type of sample collected. For each round of sampling, duplicate samples are collected from a selected sample point at the same time as the original sample to check for consistency in the sampling process. The duplicate sample serves as a check on the precision of the sampling and analytical procedures. Decontamination rinseates are analyzed whenever the potential exists for cross-contamination from sampling equipment. Trip blanks are sent with each shipment of water samples requiring analysis for volatiles. Field blanks are collected to check for contamination during the water sampling process. Calibration records for each field instrument are maintained in the contractor project files.

7.2 Laboratory Quality Assurance

Contracted laboratories providing analytical services for the LEHR ER/WM Project are evaluated by WA or UC Davis to ensure compliance with the QA program requirements. Laboratory QA is analyzed externally by submitting split samples, spiked samples, and blanks to the laboratories analyzing environmental samples. Laboratories must submit their analytical procedure for review if it differs from standard procedures. Each contract laboratory is required to maintain participation, as applicable, in DOE, State of California, and/or EPA approved inter-laboratory QA programs such as DOE's Environmental Measurement Laboratory Inter-Laboratory Comparison Program or EPA's Water Pollution/Water Supply Program.

7.3 Compliance Audits

Aspects of the LEHR program are audited periodically to ensure compliance with project standards. Several health and safety and QA audits or surveillances, an annual QA system audit, and a Radiation Protection Program audit were performed in 2000. All findings and observations identified during the audits have been, or will be, resolved.

7.4 Summary of Quality Control Data Validation

The overall LEHR QA objective is to collect and analyze environmental samples from the Site in a manner that ensures technical data are accurate and representative, are able to withstand scientific and legal scrutiny, and are useful for evaluating site conditions and remedial actions. The criteria used to specify QA goals are precision, accuracy, representativeness, completeness and comparability for evaluation of QC data. These parameters are evaluated through data validation. Table 7-1 summarizes the components that are used to monitor and evaluate the quality of LEHR environmental data.

Table 7-1. Components of the LEHR Quality Control Program in Support of Data Quality Objectives

Data Quality Objective	Quality Control Component	Evaluation Criteria
Precision	• Field duplicate • Matrix spike • Matrix spike duplicate	Relative percent difference
Accuracy	• Matrix spike • Matrix spike duplicate • Surrogate spikes	Percent recovery
Representativeness	• Trip blanks • Field duplicate • Method blanks	Qualitative degree of confidence
Completeness	• Holding time • Valid data points	Percent valid data
Comparability	• Analytical methods • Field duplicates	Qualitative degree of confidence

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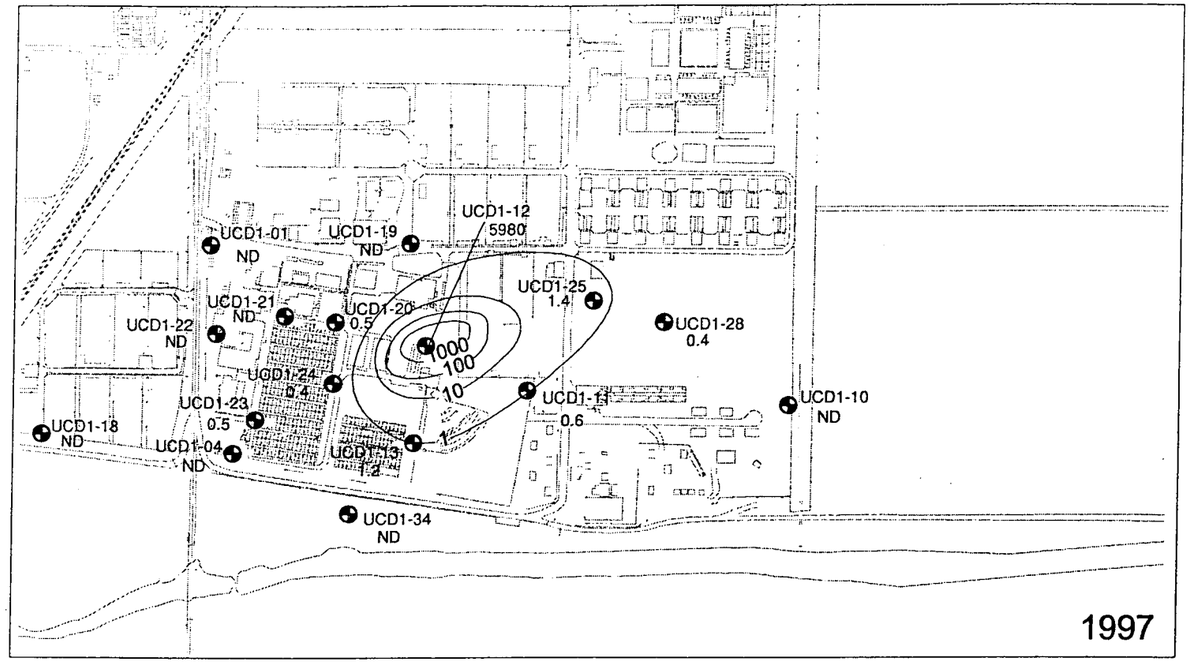
9. ACKNOWLEDGMENTS

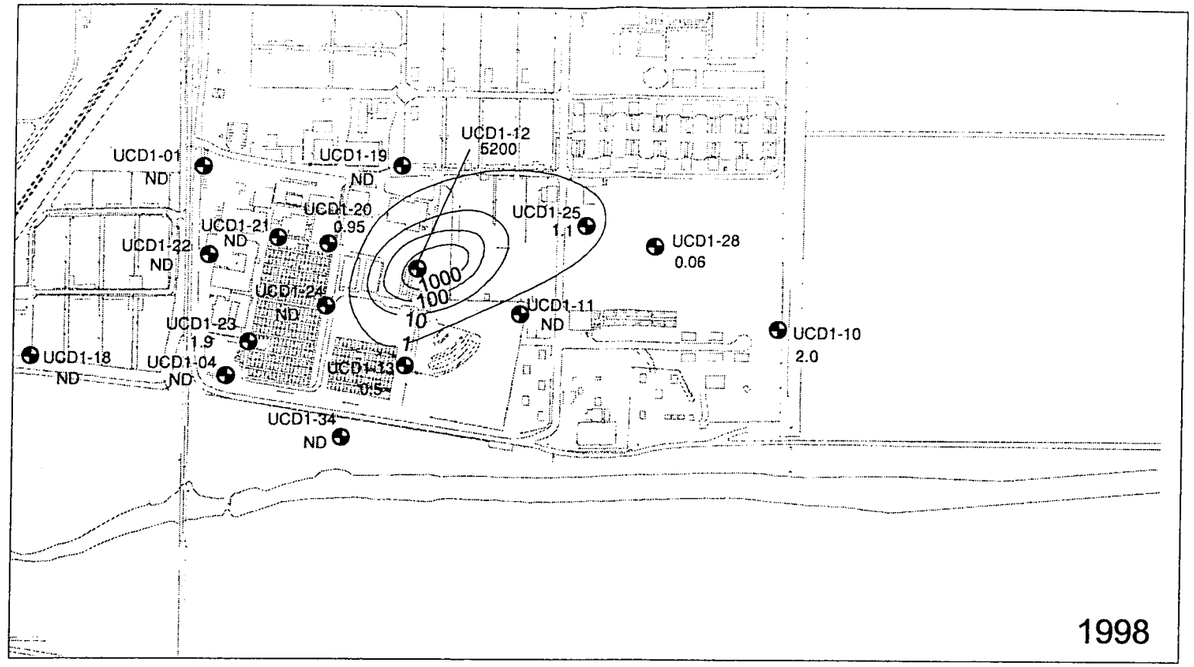
The following LEHR Project personnel worked on the 2000 ASER:

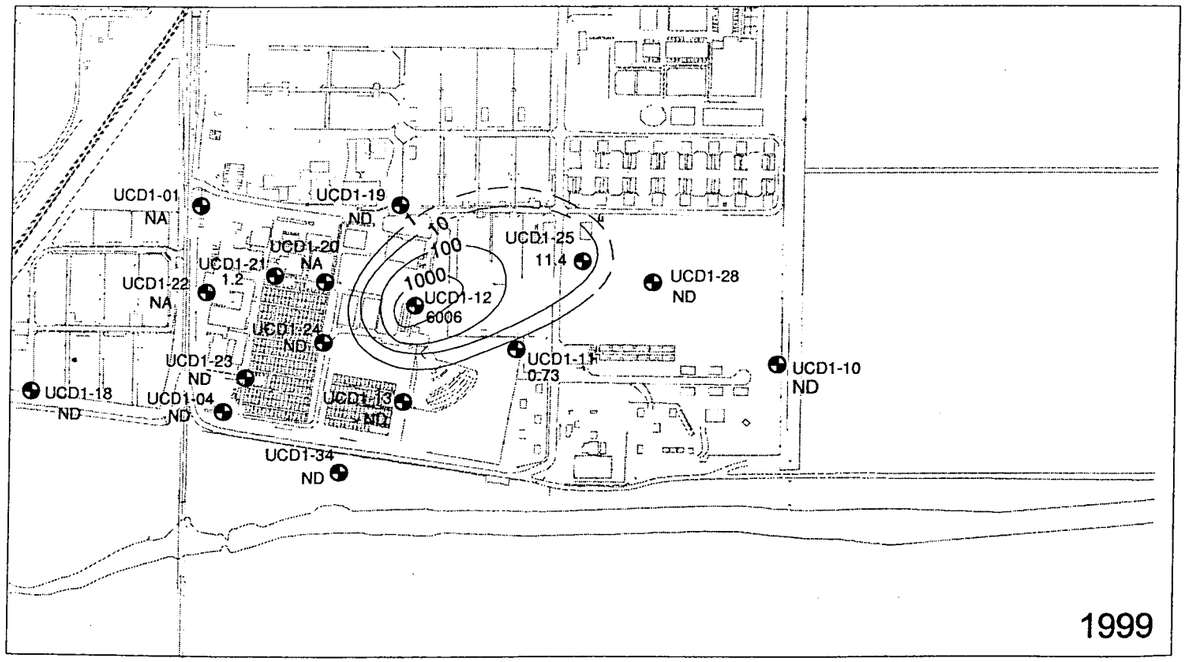
Name and Position	Responsibility
Michael Dresen LEHR Program Manager, Weiss Associates	Senior guidance, review, and quality assurance
Robert Devany LEHR Project Manager, Weiss Associates	Project management, technical guidance and review
Salem Attiga Principal, EMS	Senior review
Mary Stallard Project Manager, Weiss Associates	Technical guidance and review
Dolores Loll LEHR Quality Assurance, Weiss Associates	Technical review and quality assurance
Joyce Adams Project Geologist, Weiss Associates	Project coordination and report writing
Maile Smith Sr. Staff Geologist, Weiss Associates	Report writing
Craig Adams Graphics, Weiss Associates	Graphics
Nerissa de Jesus Project Administrator, Weiss Associates	Word processing and report coordination
Ted Trammel Production Personnel, Weiss Associates	Graphics and report production

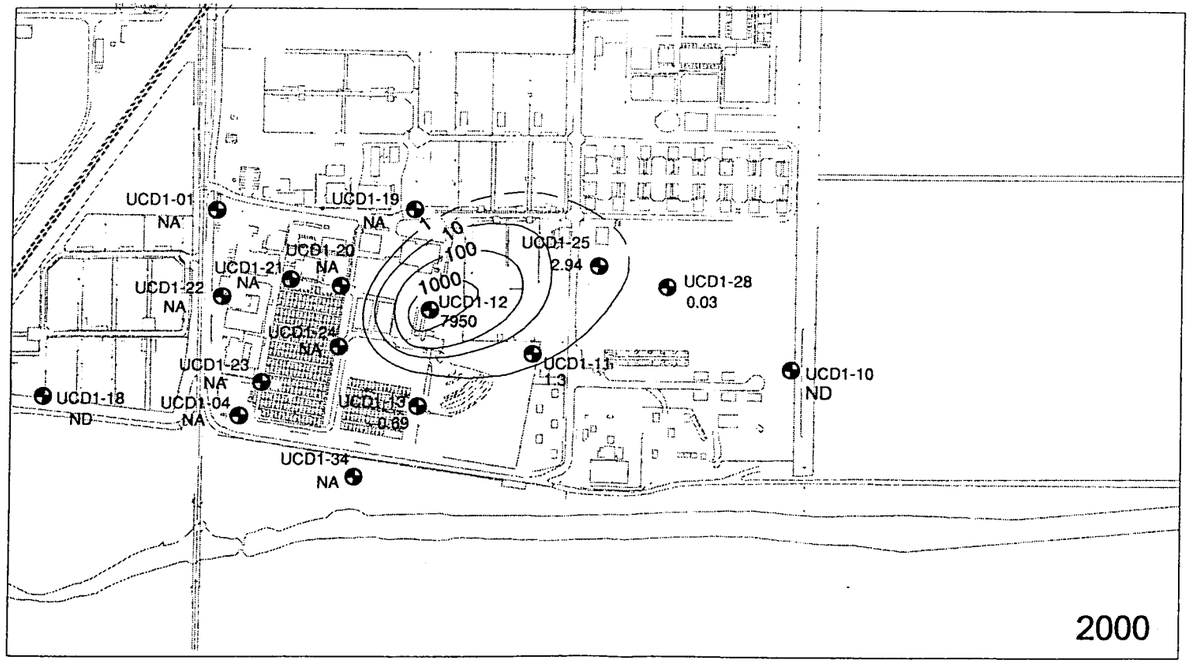
APPENDIX A

ISOCONCENTRATION MAPS FOR HSU-1 AND HSU-2









LEGEND

UCD2-17 HSU-2 Monitoring Well
All results reported in pCi/L
Results represent average of quarterly data
NA = Not Analyzed
ND = Not Detected

CHLOROFORM ISOCONCENTRATION CONTOURS IN HSU-1, 1997 THROUGH 2000

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FIGURE 21

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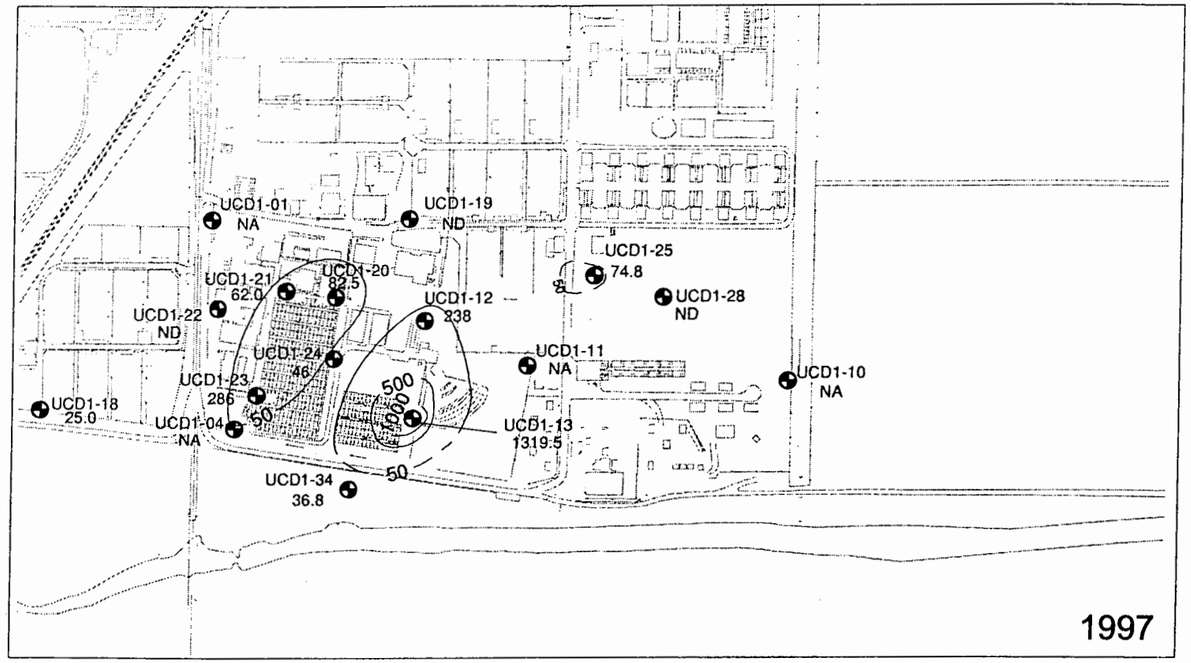

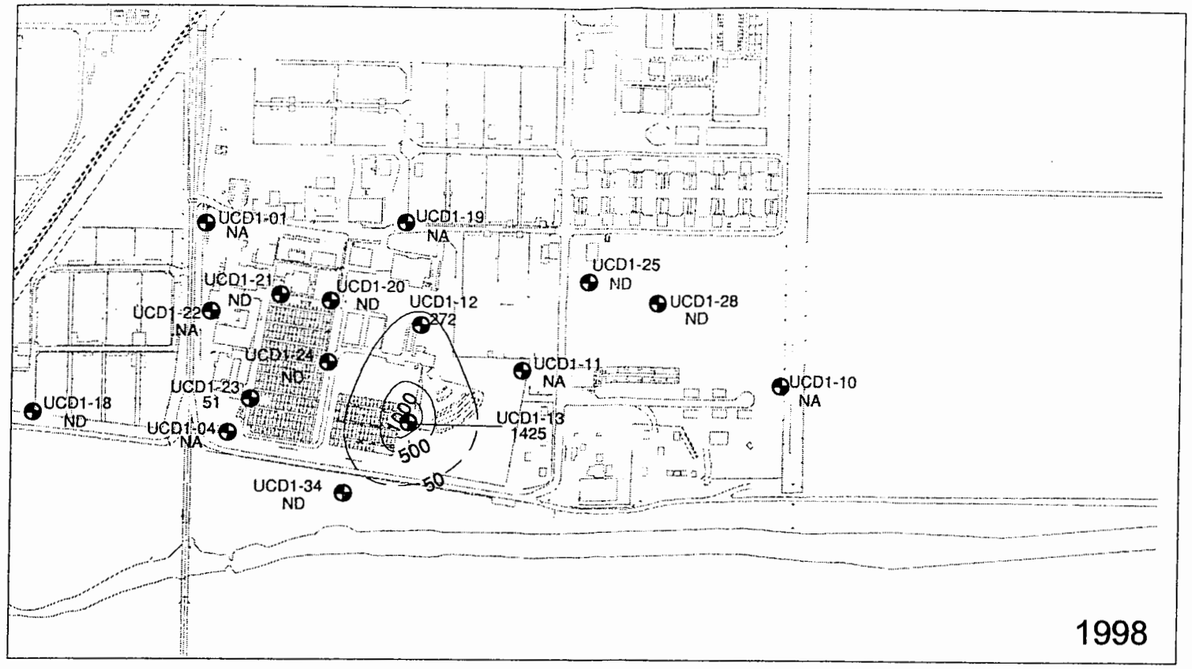

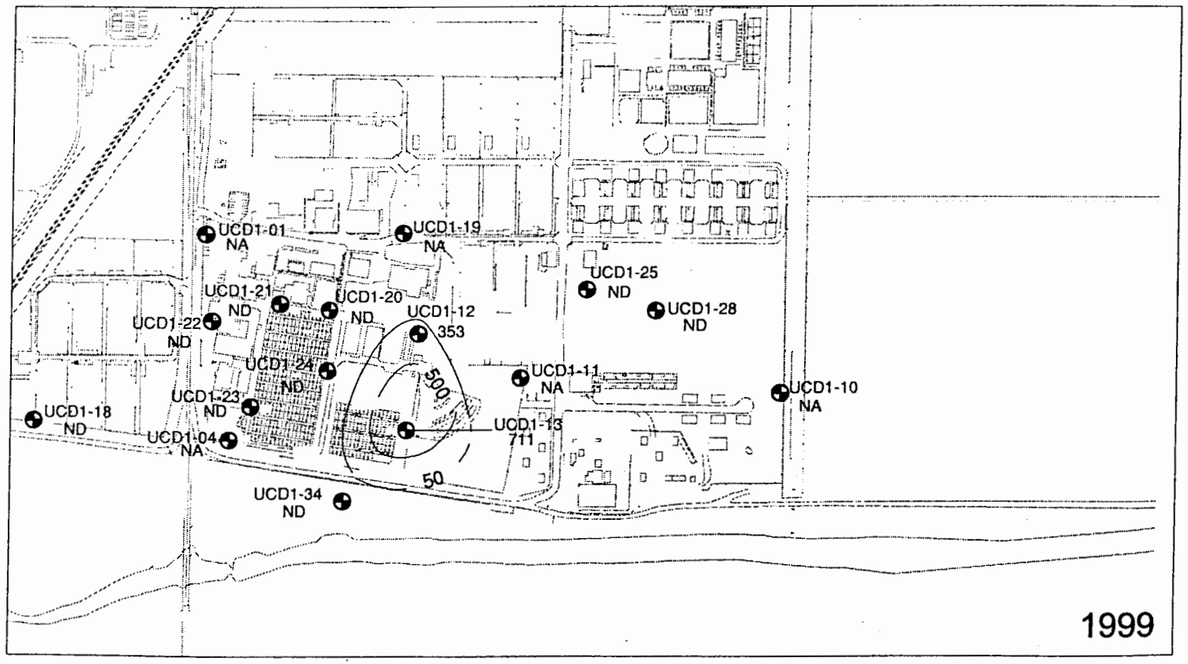

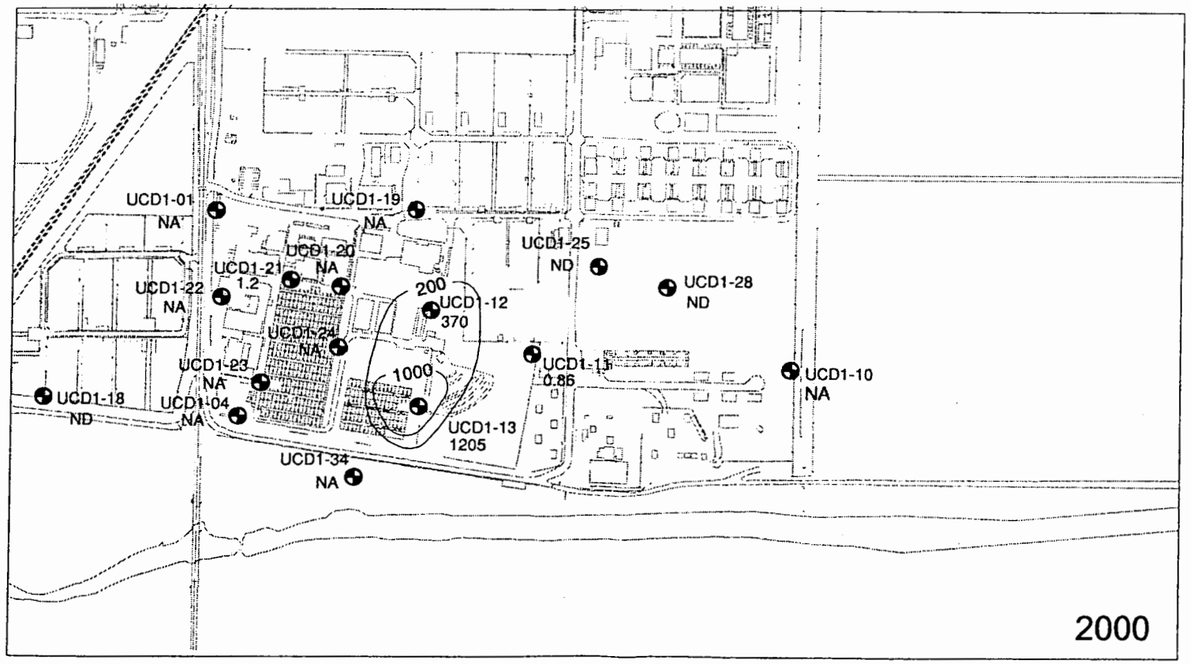

LEGEND

UCD2-17 HSU-2 Monitoring Well
All results reported in pCi/L
Results represent average of quarterly data
NA = Not Analyzed
ND = Not Detected

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CARBON-14 ISOCONCENTRATION CONTOURS IN HSU-1, 1997 THROUGH 2000

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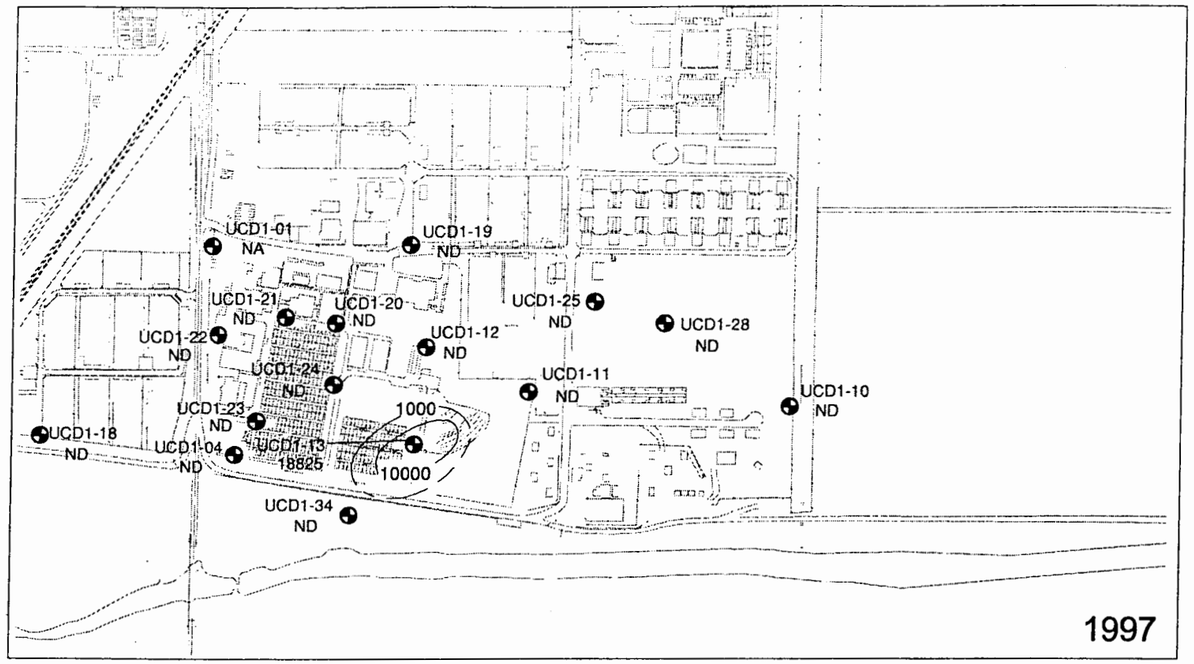
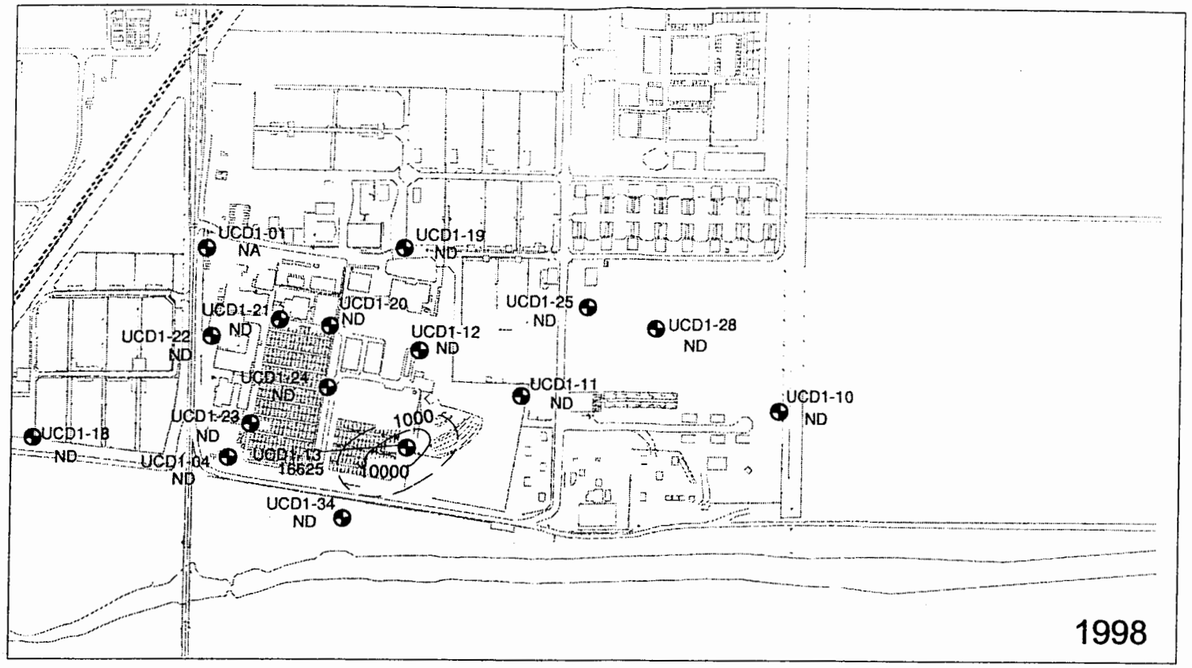
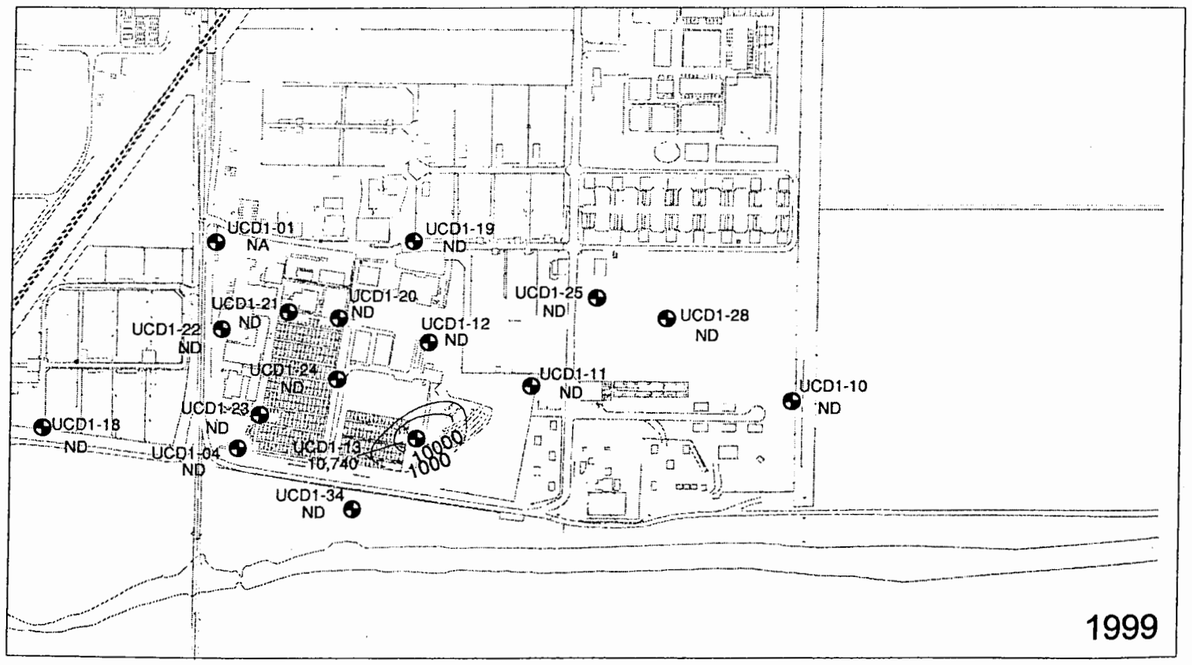
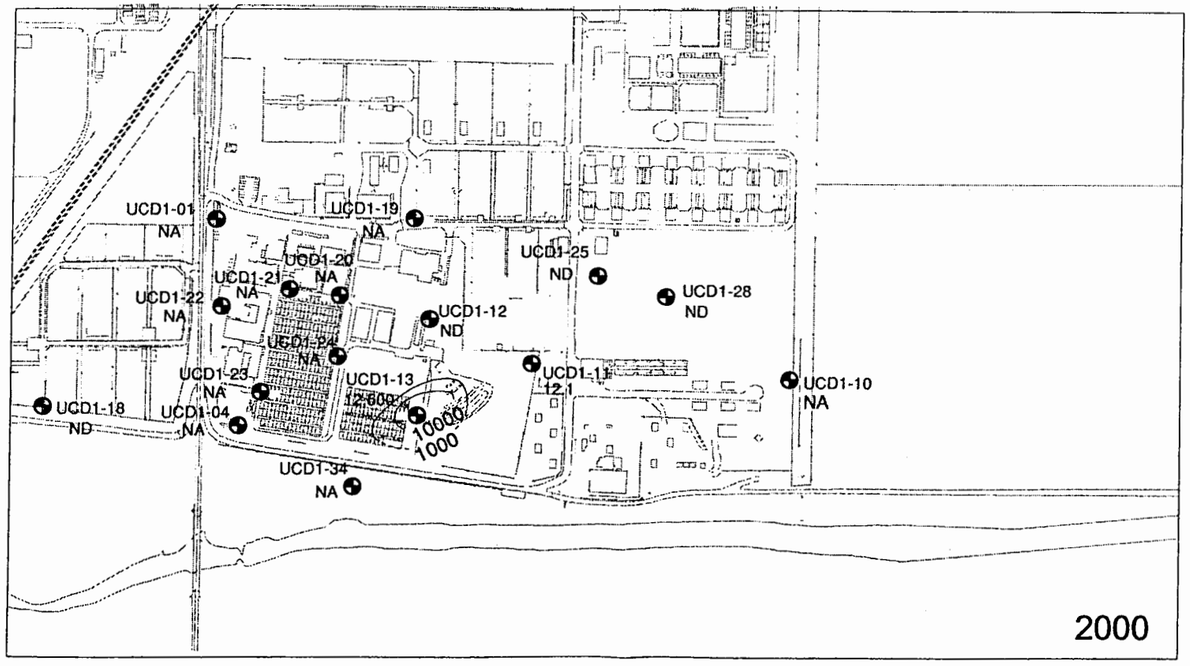
FIGURE 22









LEGEND

- UCD2-17 HSU-2 Monitoring Well
- All results reported in pCi/L
- Results represent average of quarterly data
- NA = Not Analyzed
- ND = Not Detected

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TRITIUM ISOCONCENTRATION CONTOURS IN HSU-1, 1997 THROUGH 2000

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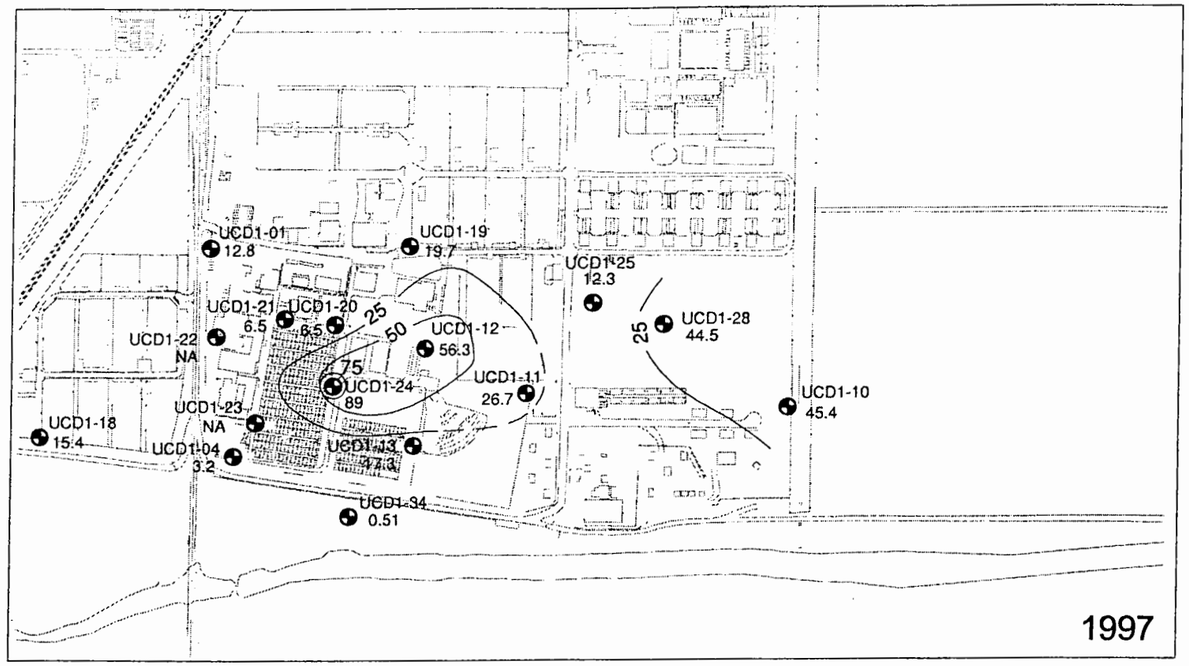
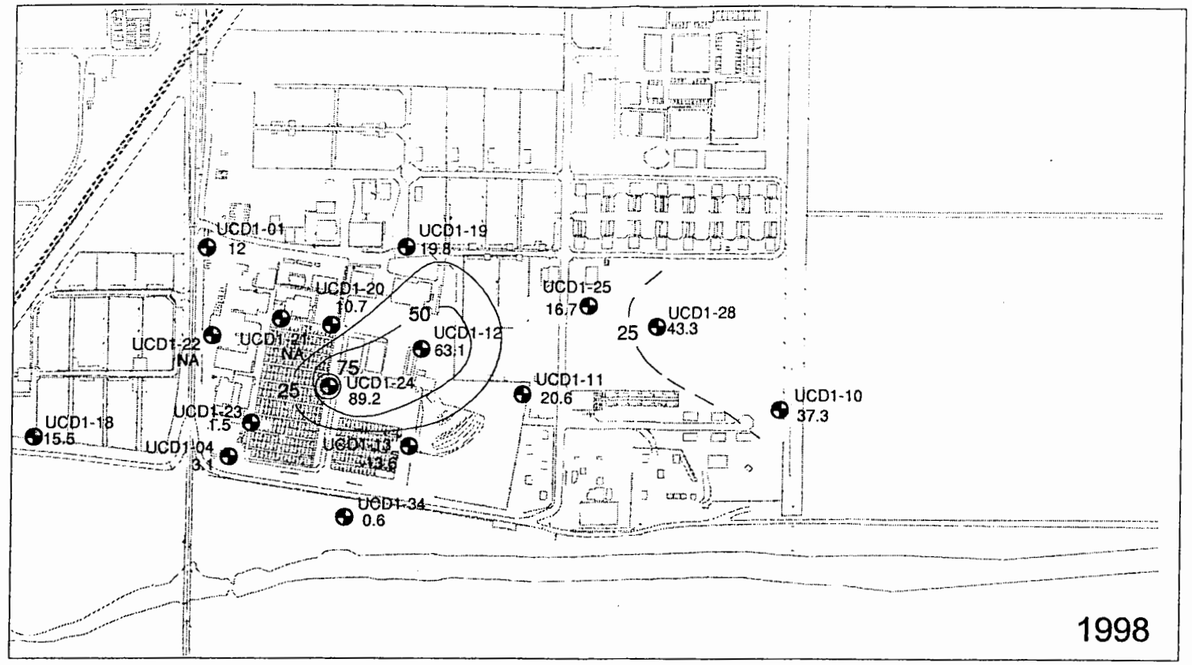
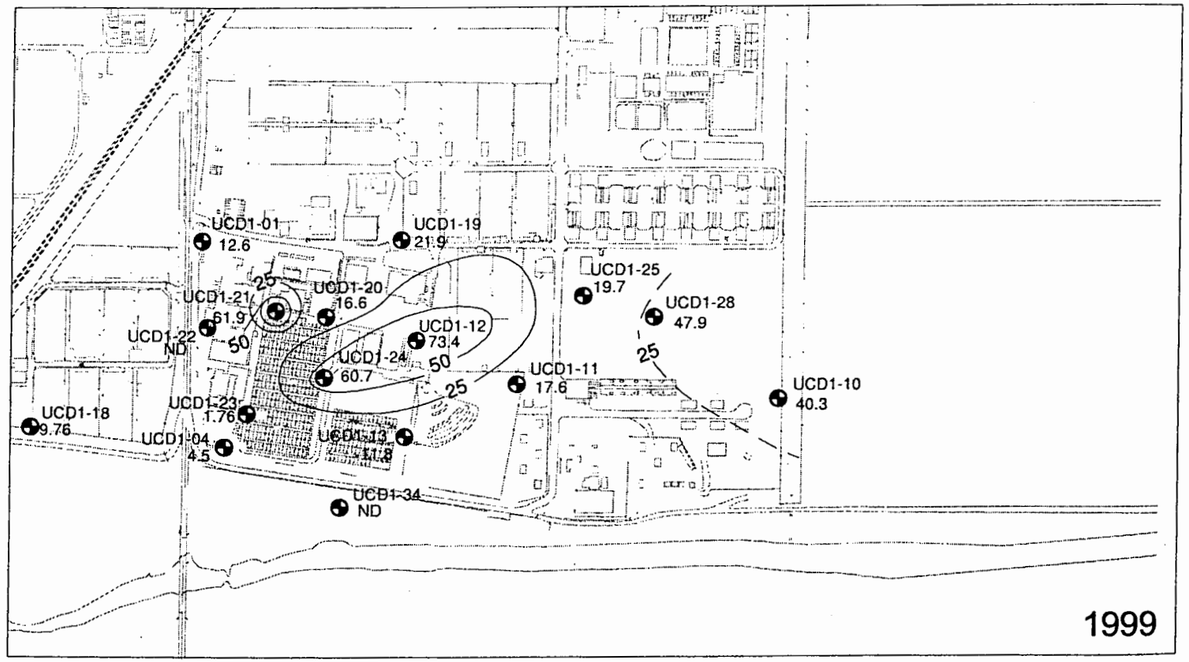
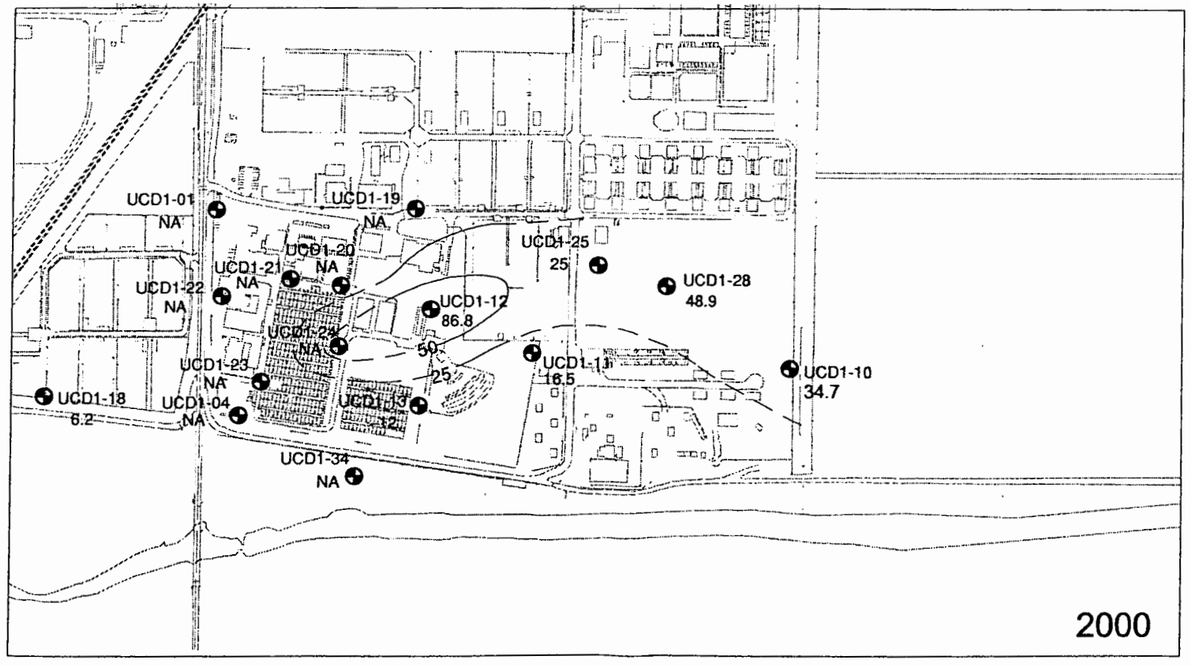
FIGURE 23









LEGEND

- UCD2-17 HSU-2 Monitoring Well
- All results reported in pCi/L
- Results represent average of quarterly data
- NA = Not Analyzed
- ND = Not Detected

NITRATE AS N ISOCONCENTRATION CONTOURS IN HSU-1, 1997 THROUGH 2000

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FIGURE 24

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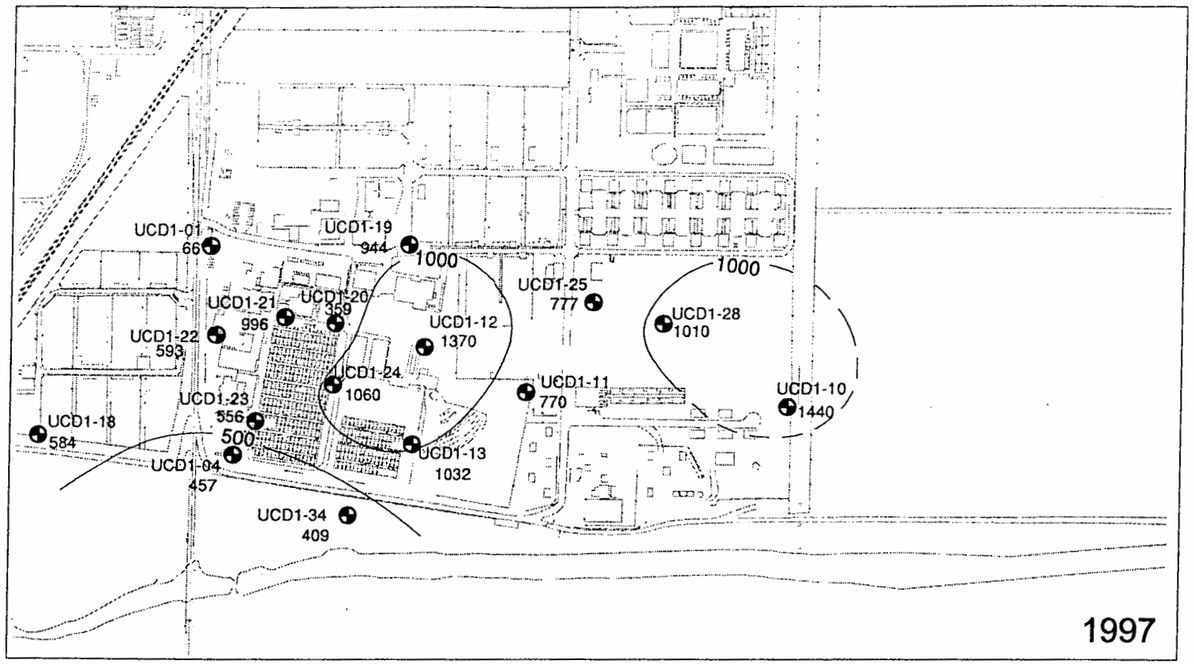

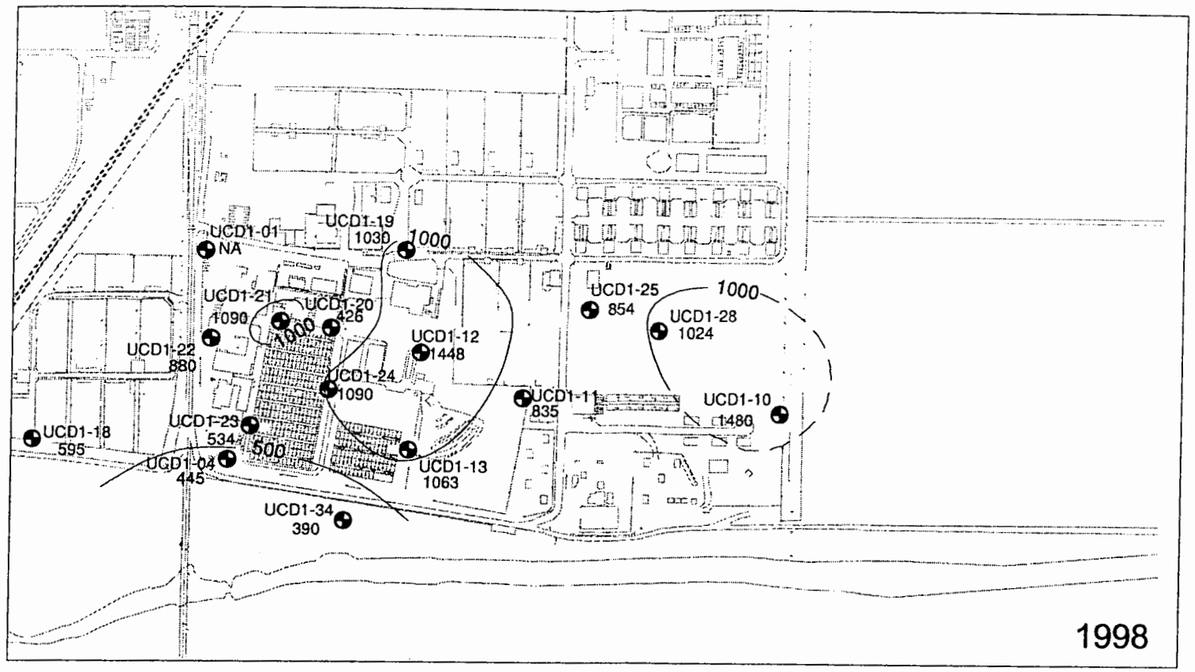

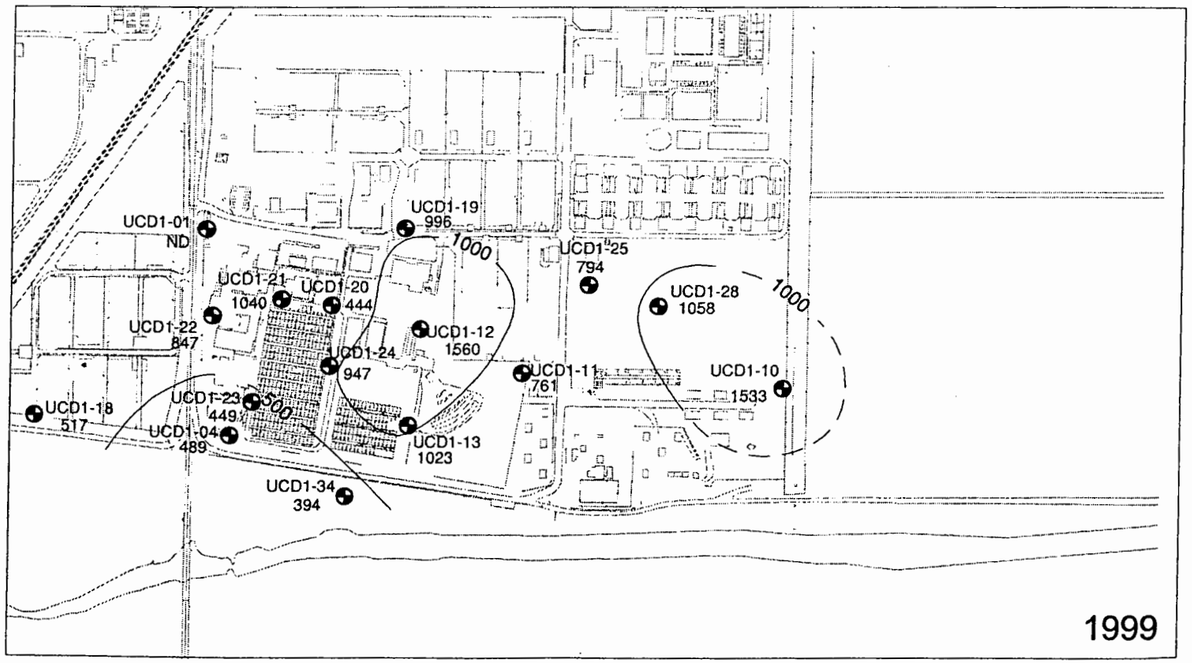

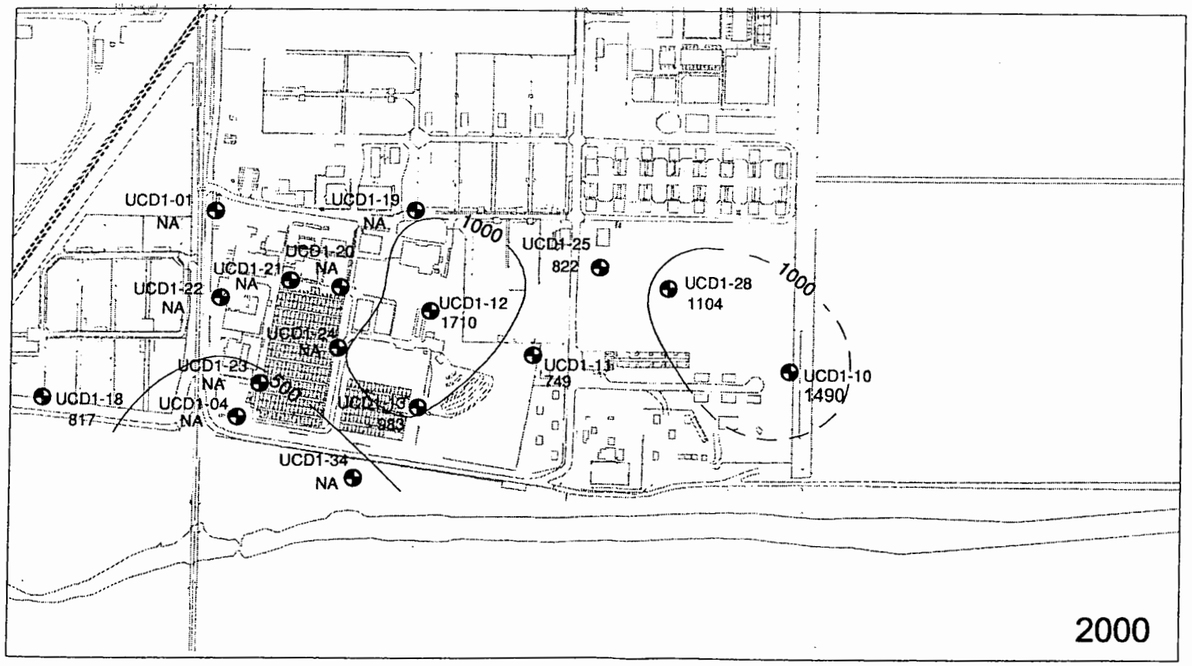

LEGEND

- UCD2-17 HSU-2 Monitoring Well
- All results reported in pCi/L
- Results represent average of quarterly data
- NA = Not Analyzed
- ND = Not Detected

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TDS ISOCONCENTRATION CONTOURS IN HSU-1, 1997 THROUGH 2000

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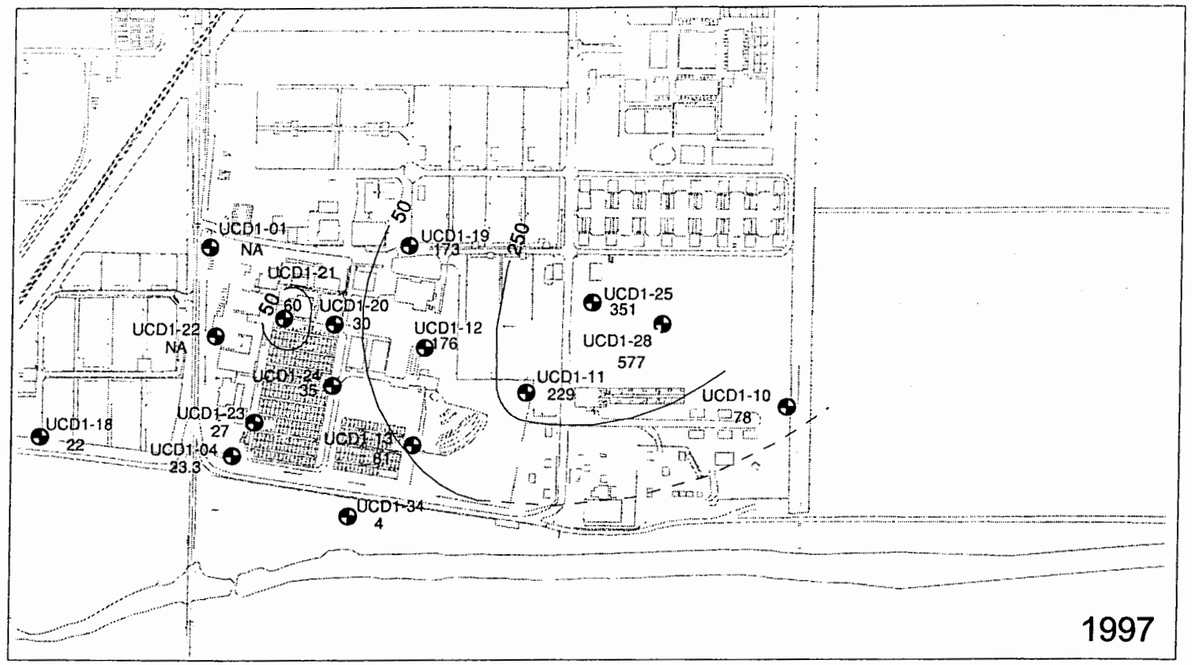
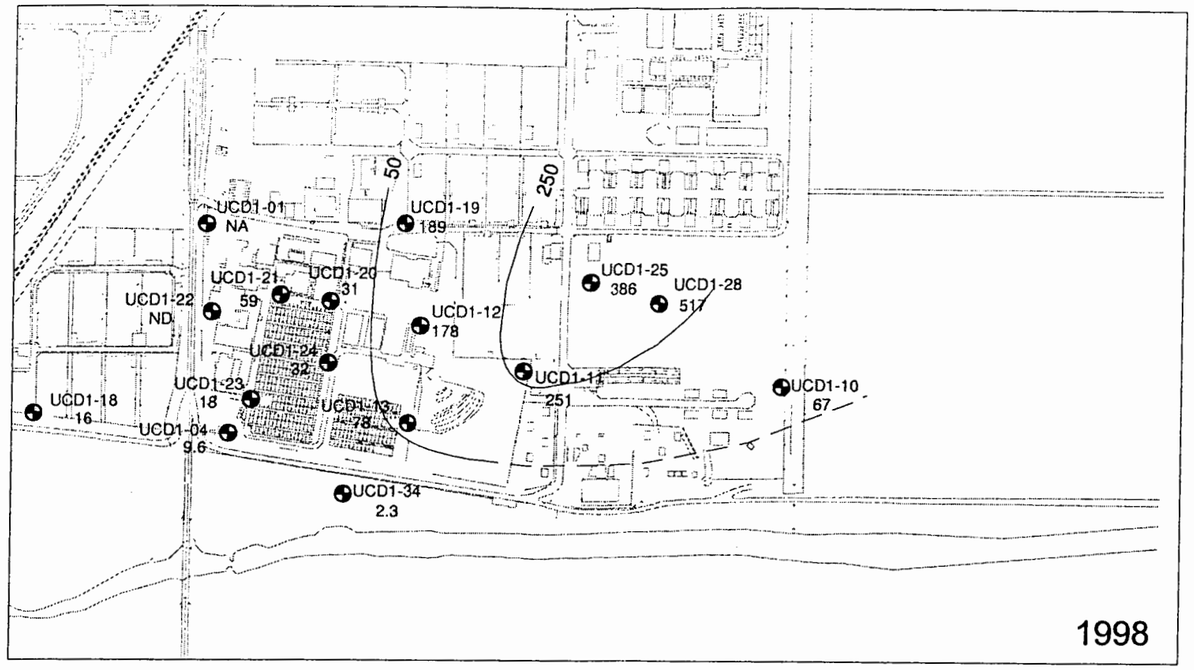
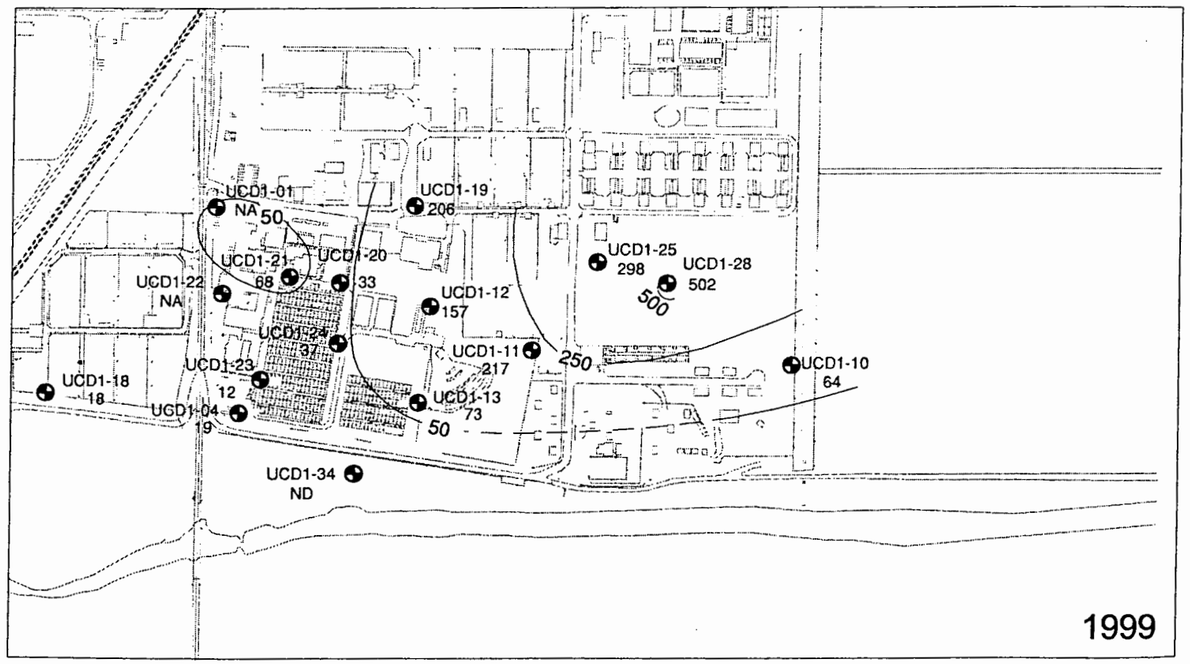
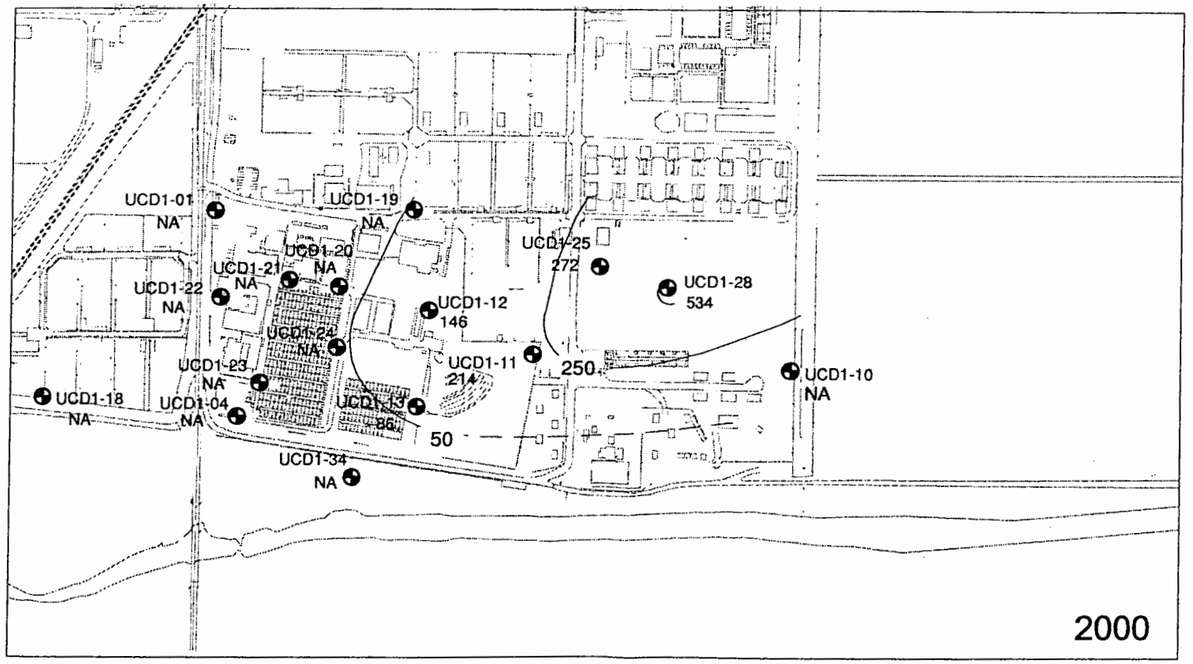
FIGURE 25









LEGEND

- UCD2-17 HSU-2 Monitoring Well
- All results reported in pCi/L
- Results represent average of quarterly data
- NA = Not Analyzed
- ND = Not Detected

CHROMIUM ISOCONCENTRATION CONTOURS IN HSU-1, 1997 THROUGH 2000

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FIGURE 26

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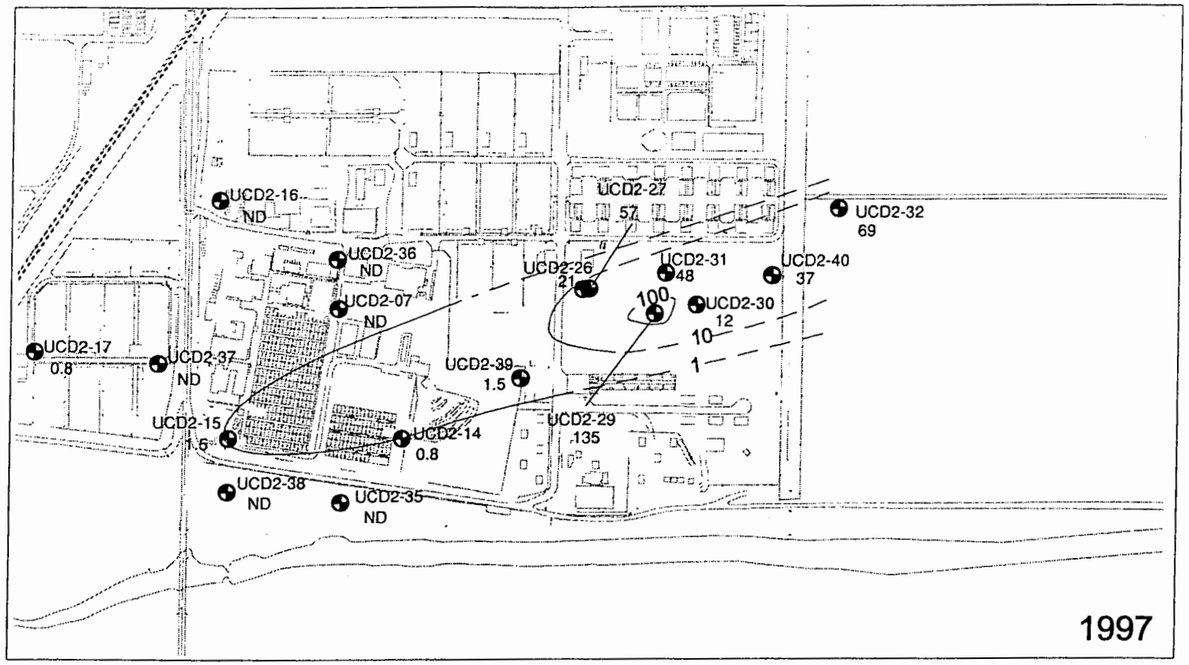

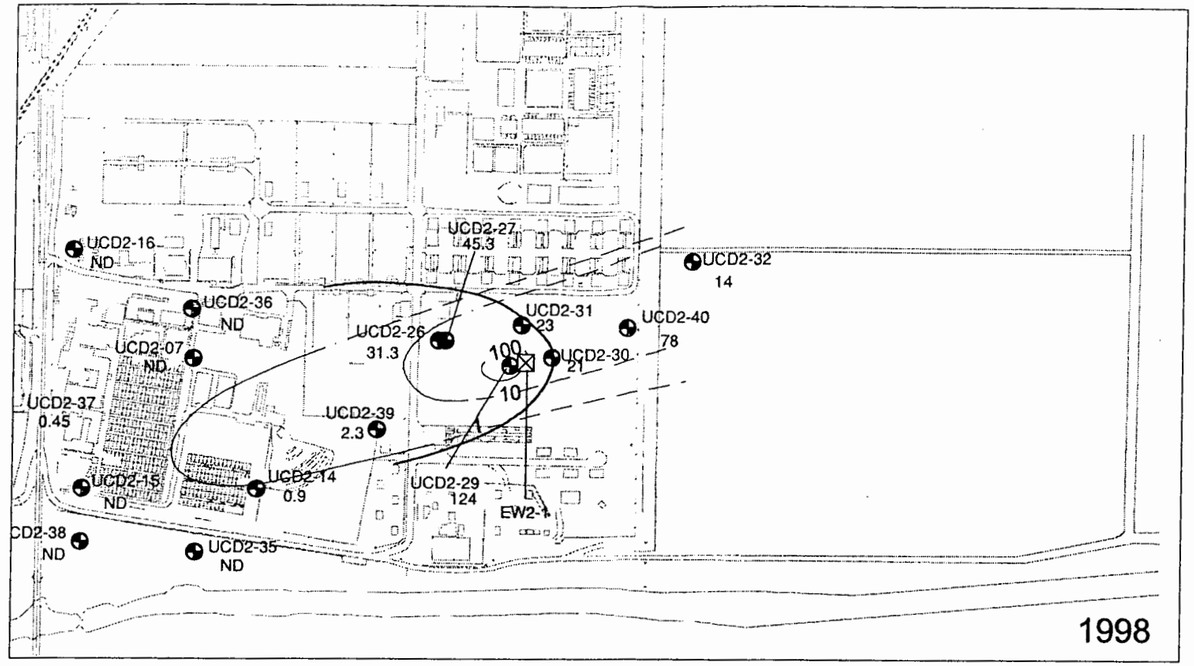

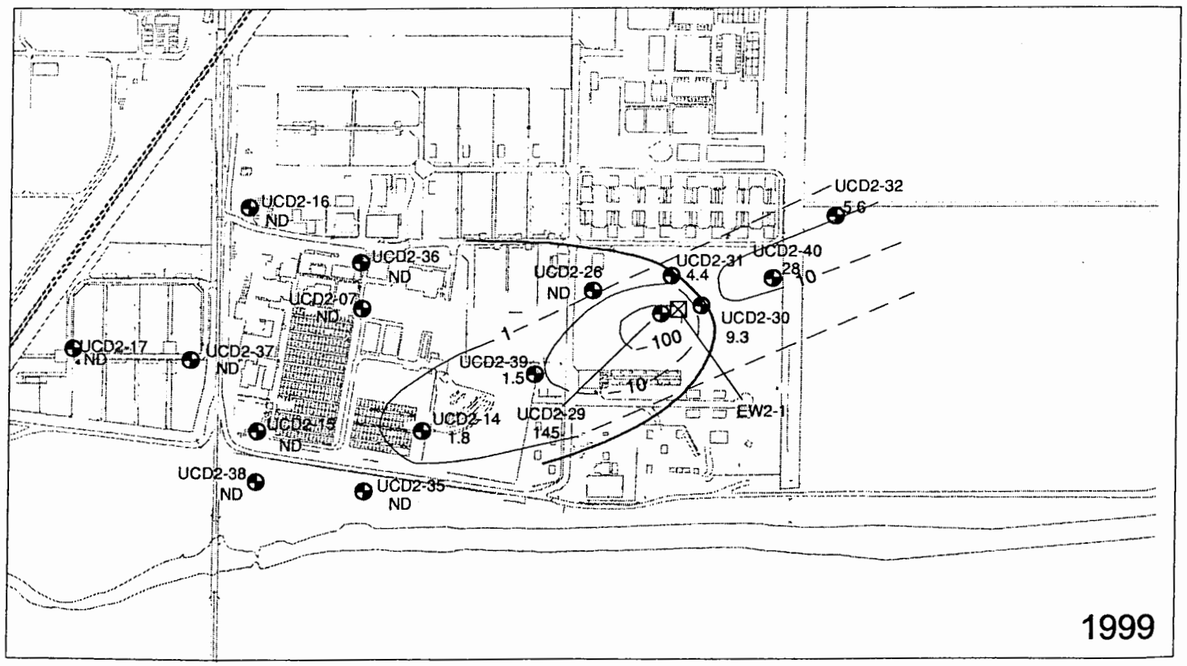

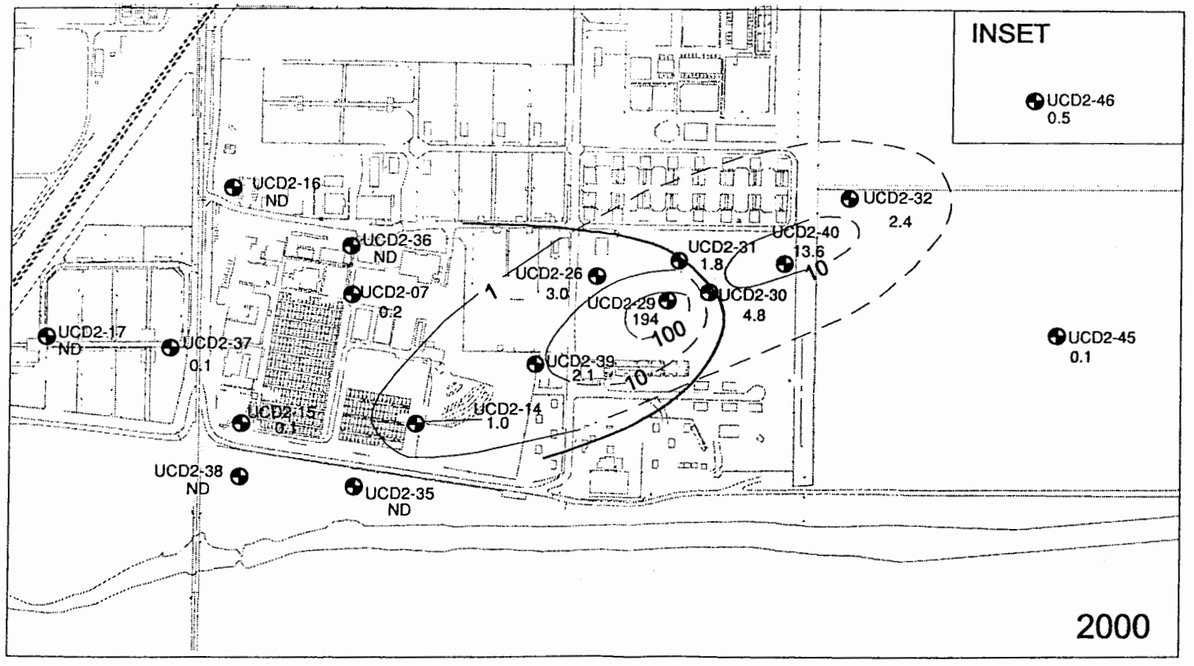

LEGEND

- UCD2-17 HSU-2 Monitoring Well
- All results reported in pCi/L
- Results represent average of quarterly data
- NA = Not Analyzed
- ND = Not Detected
- Extraction Well Capture Zone

CHLOROFORM ISOCONCENTRATION CONTOURS IN HSU-2, 1997 THROUGH 2000

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FIGURE 27

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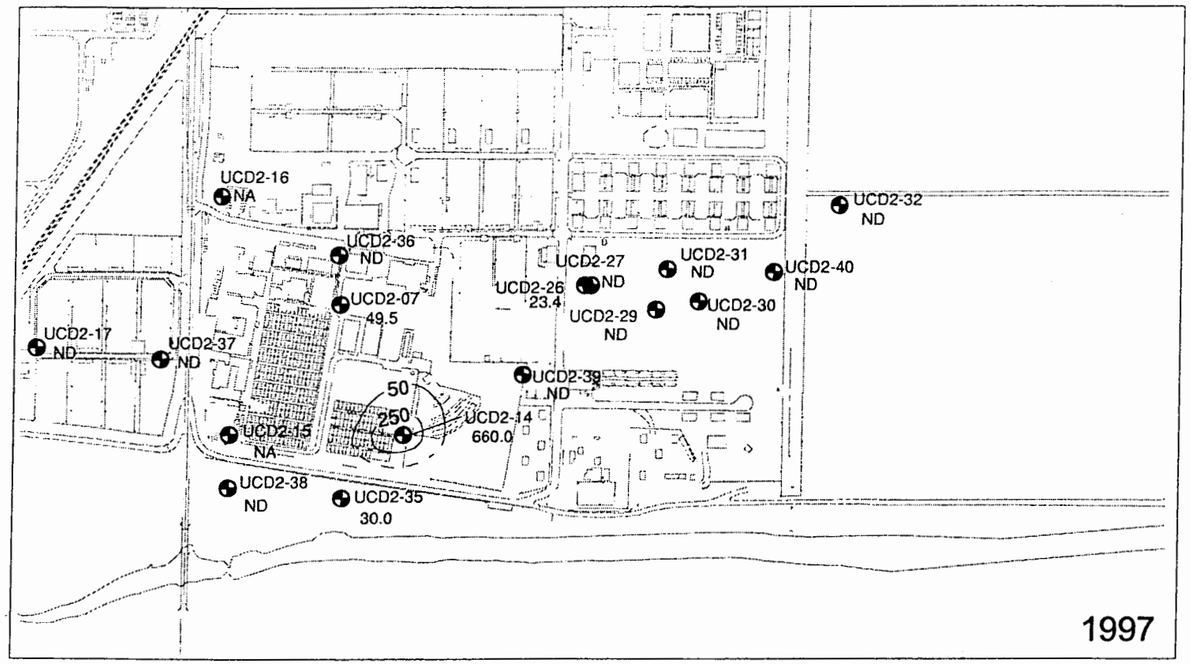

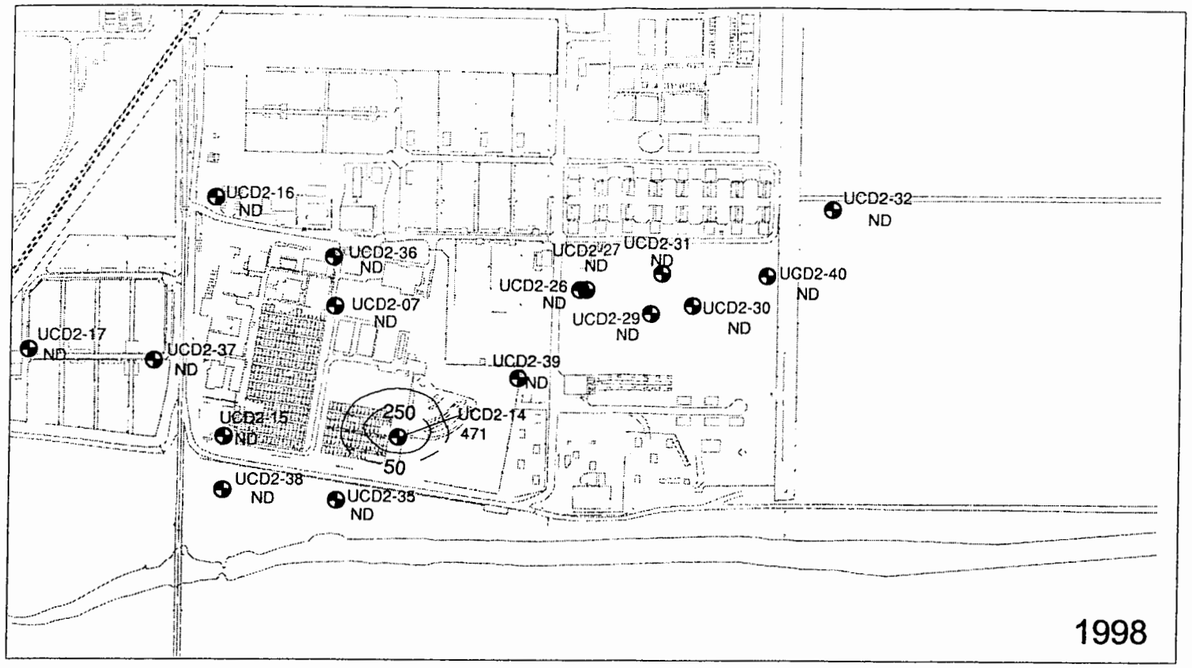

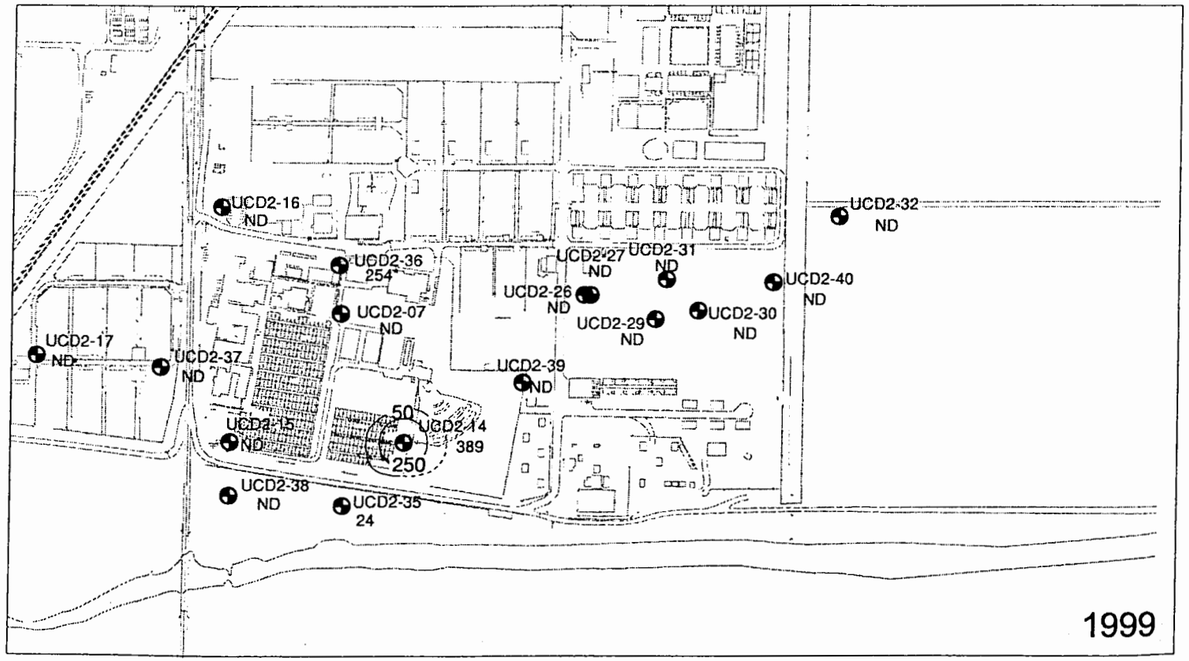

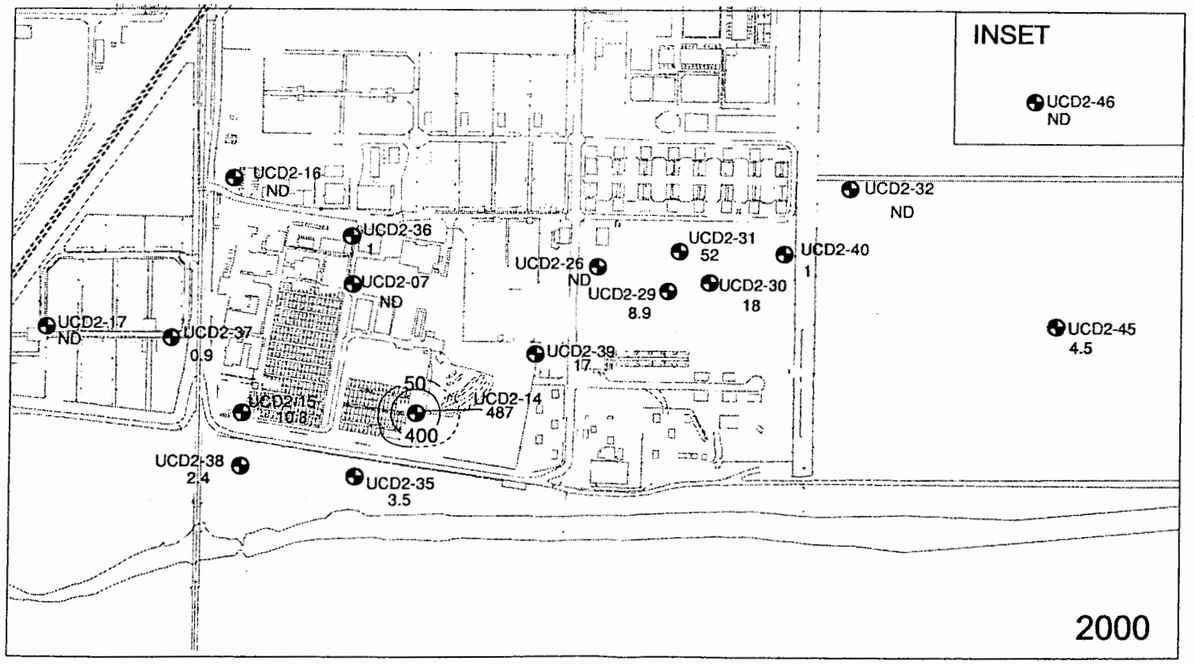

LEGEND

UCD2-17 HSU-2 Monitoring Well
All results reported in pCi/L
Results represent average of quarterly data
NA = Not Analyzed
ND = Not Detected

CARBON-14 ISOCONCENTRATION CONTOURS IN HSU-2, 1997 THROUGH 2000

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FIGURE 28

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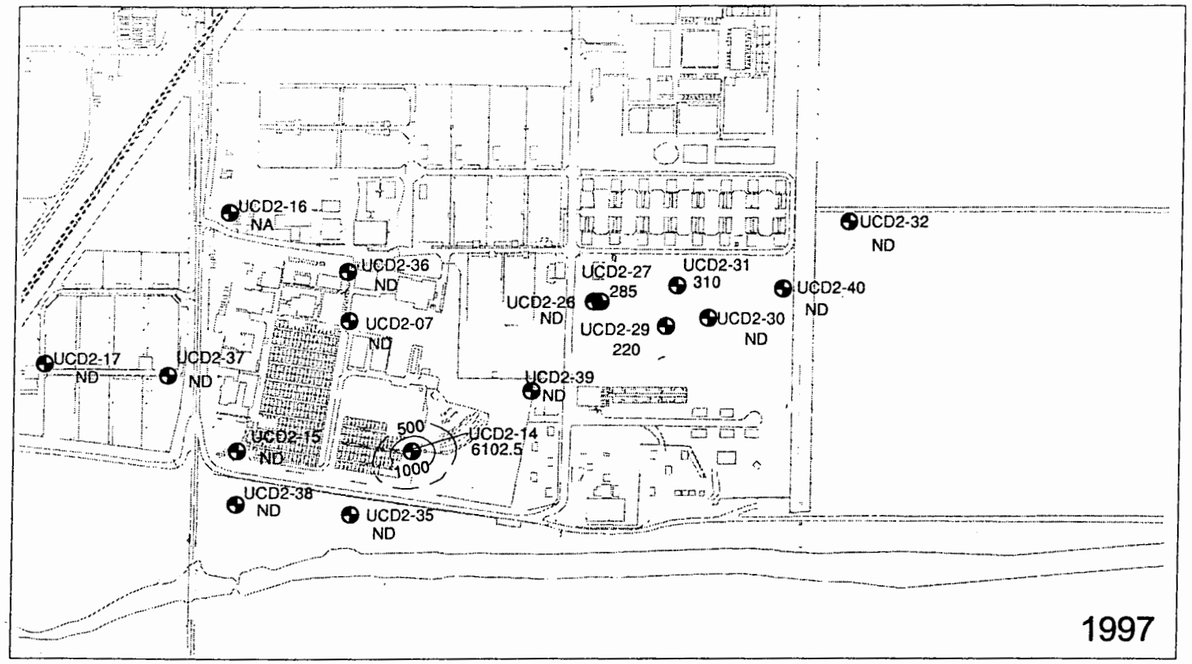

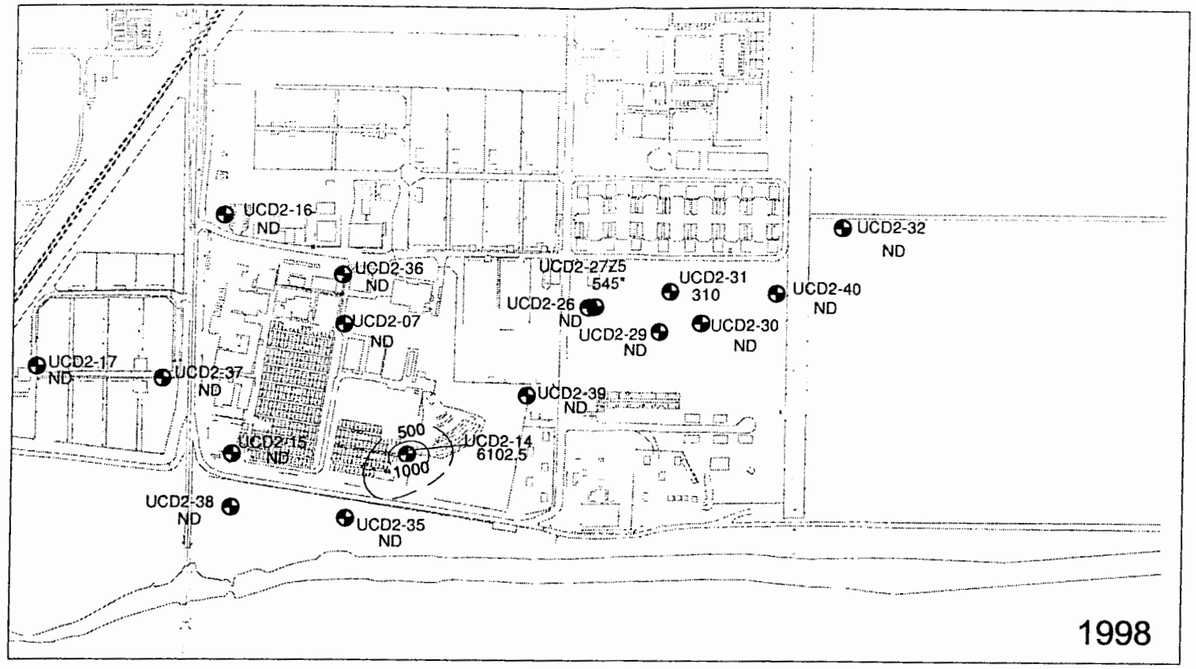

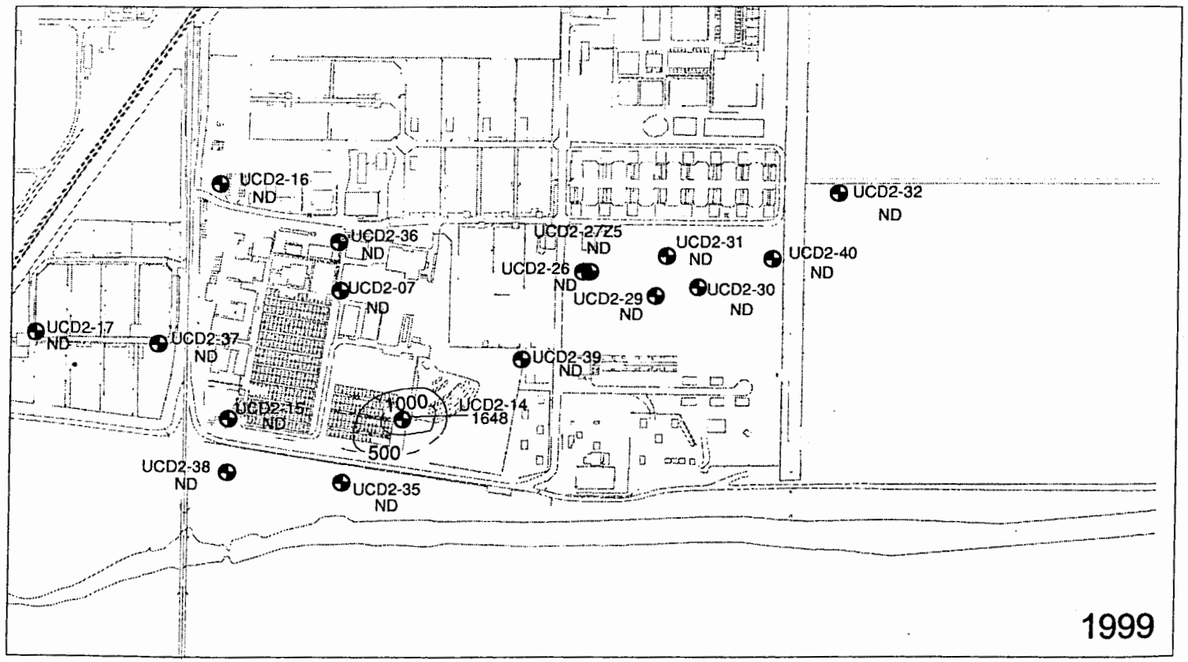

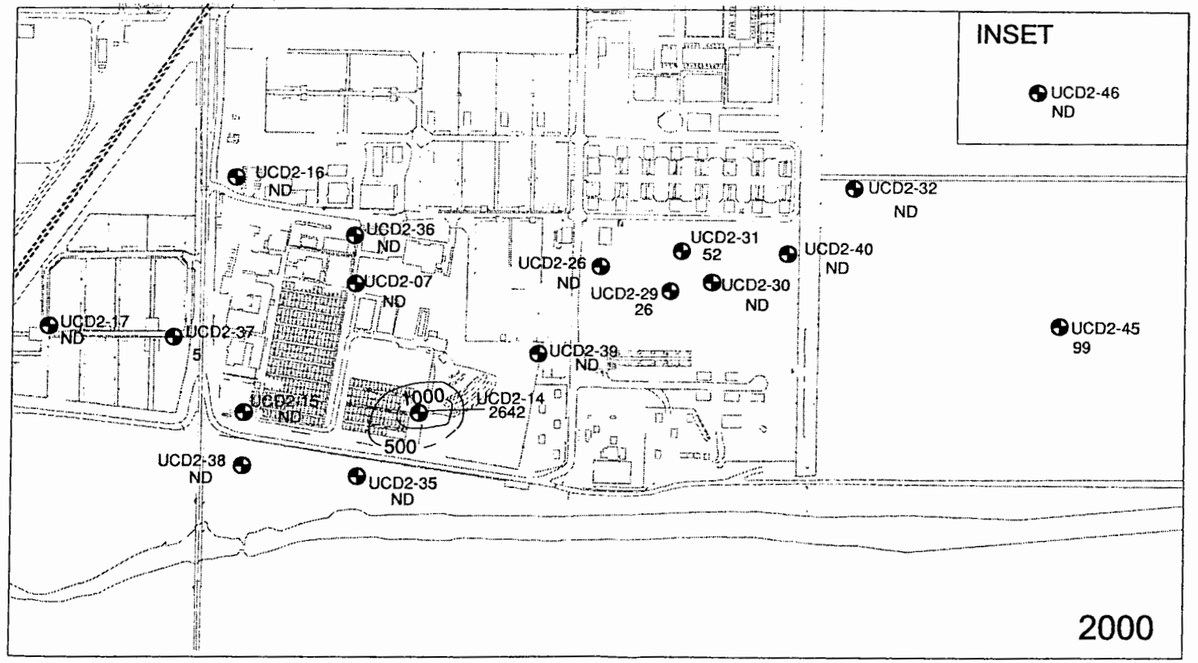

LEGEND

UCD2-17 HSU-2 Monitoring Well
All results reported in pCi/L
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TRITIUM ISOCONCENTRATION CONTOURS IN HSU-2, 1997 THROUGH 2000

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FIGURE 29

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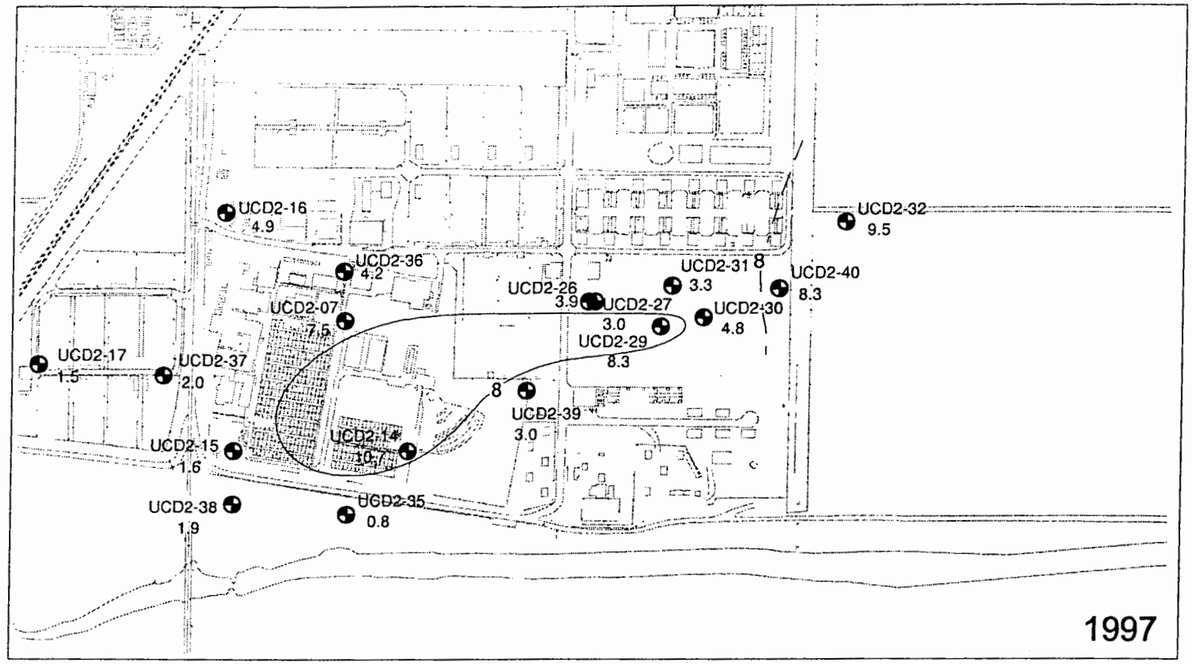

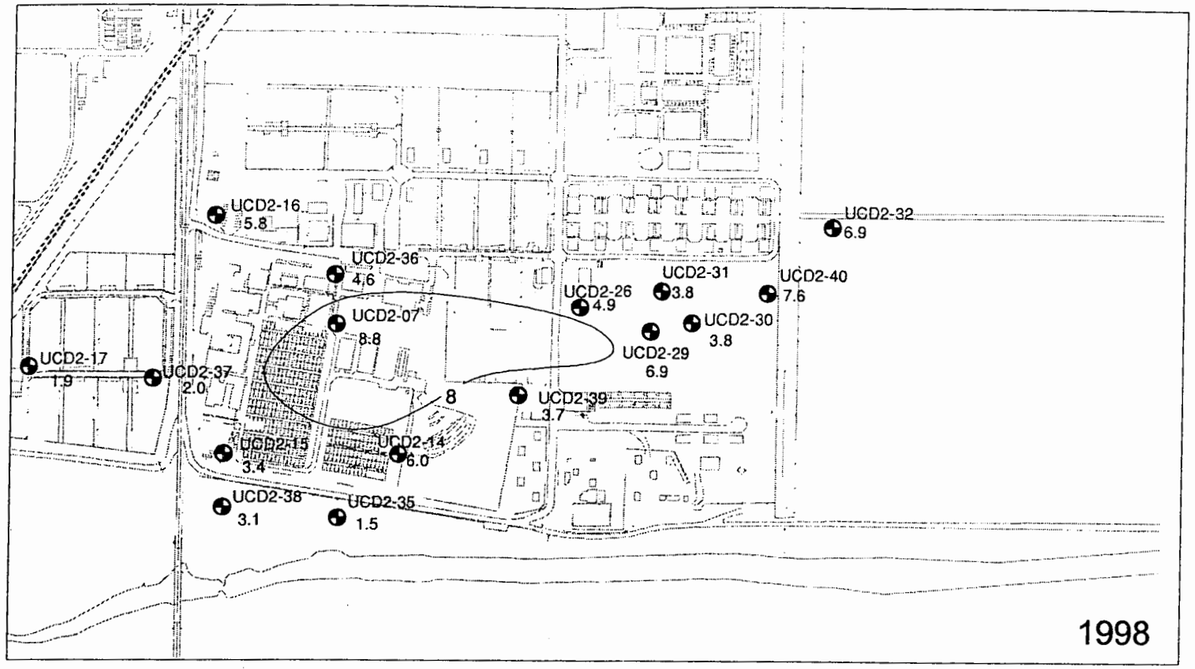

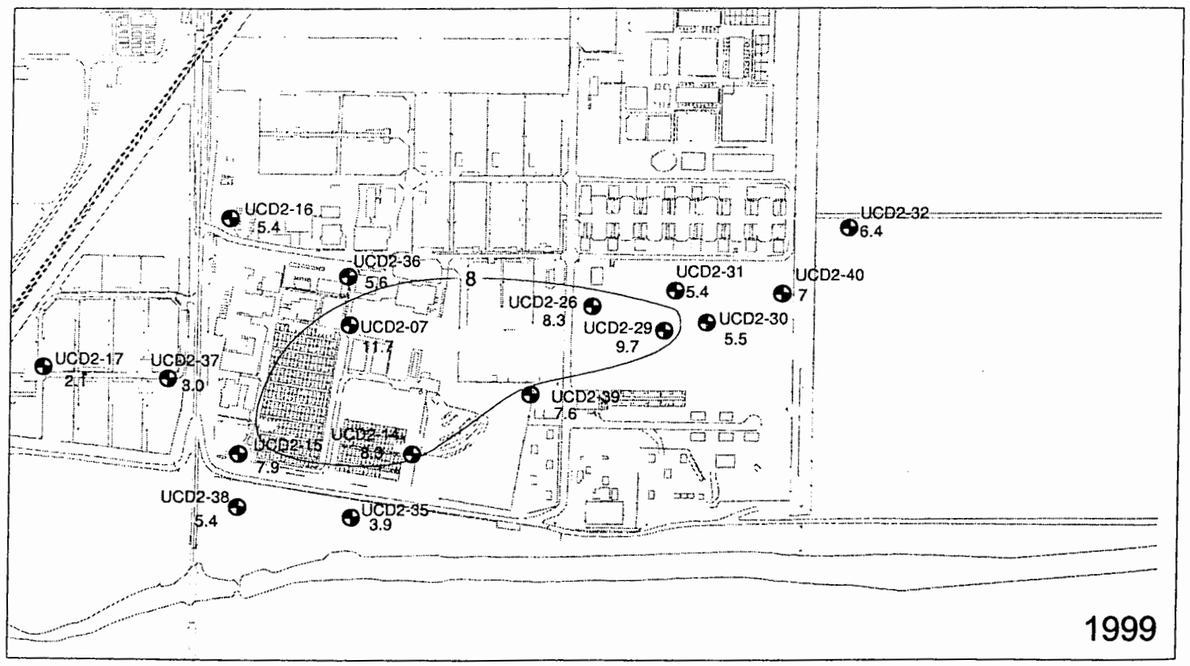

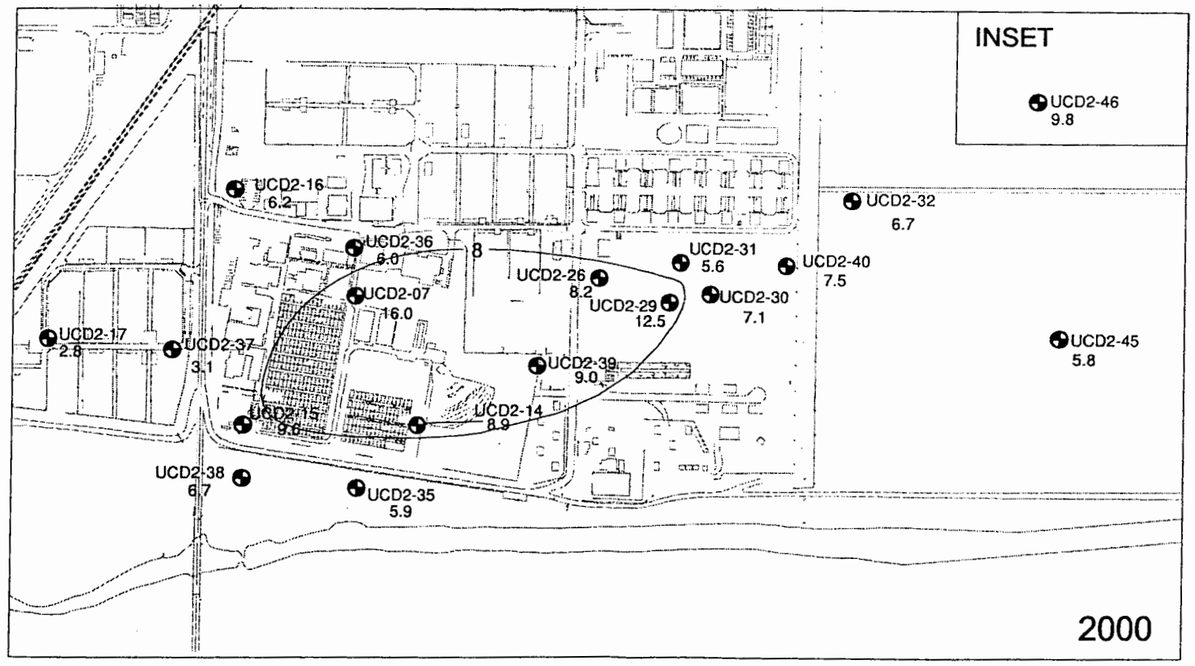

LEGEND

UCD2-17 HSU-2 Monitoring Well
All results reported in pCi/L
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ND = Not Detected

NITRATE AS N ISOCONCENTRATION CONTOURS IN HSU-2, 1997 THROUGH 2000

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FIGURE 30

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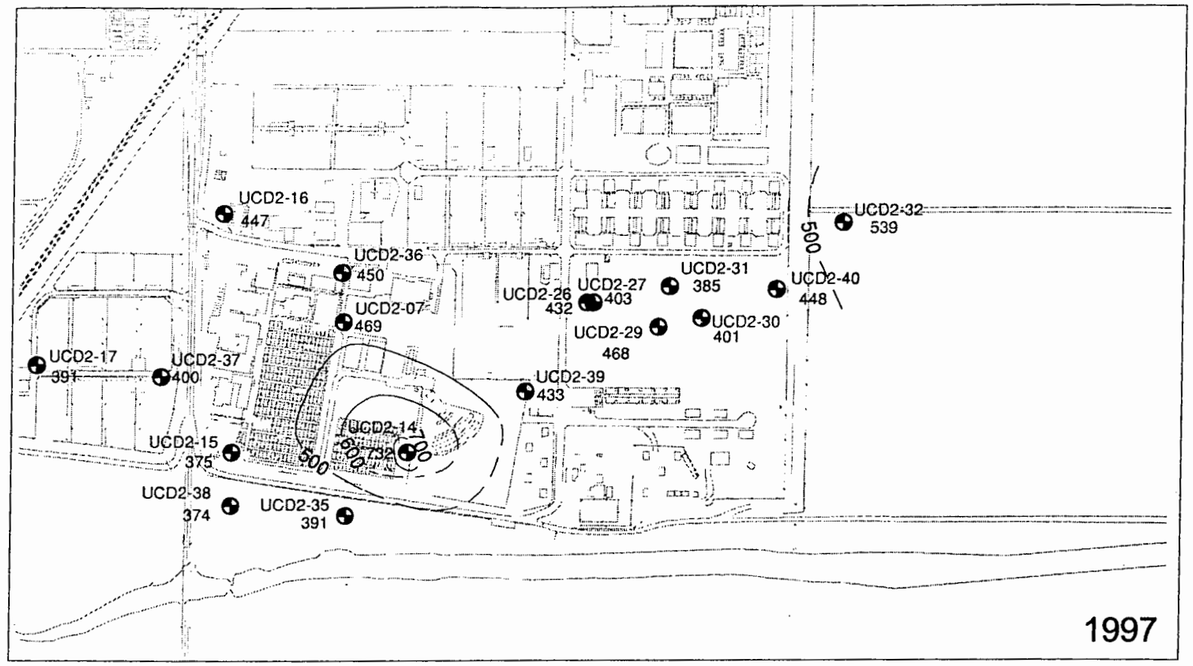

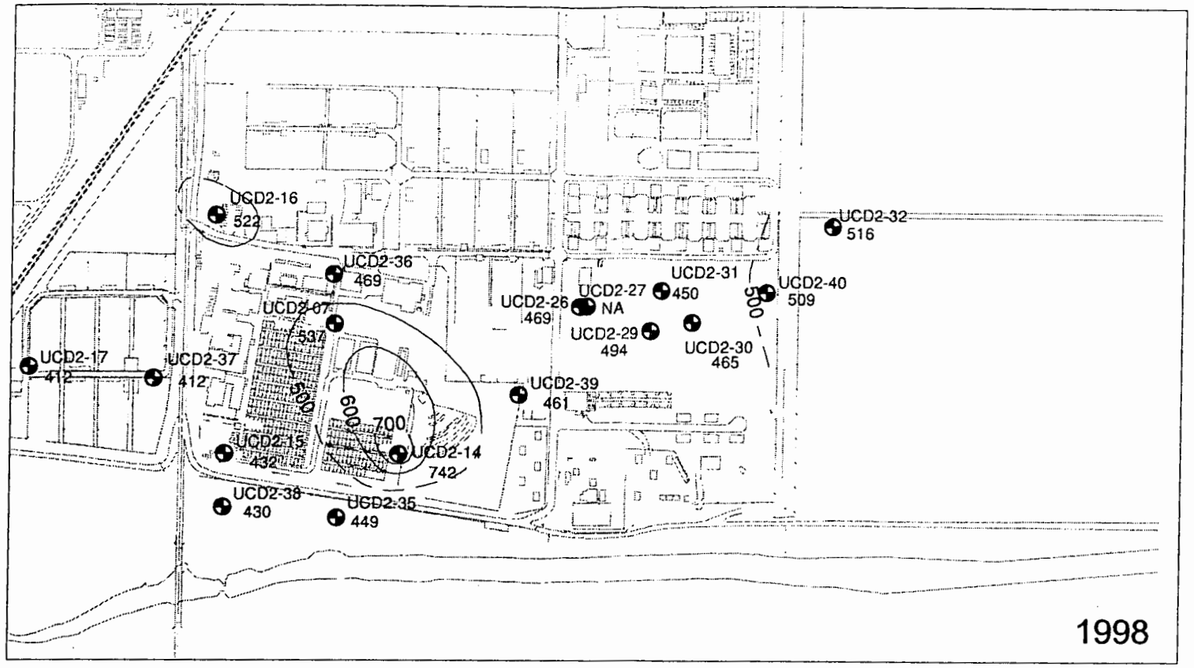

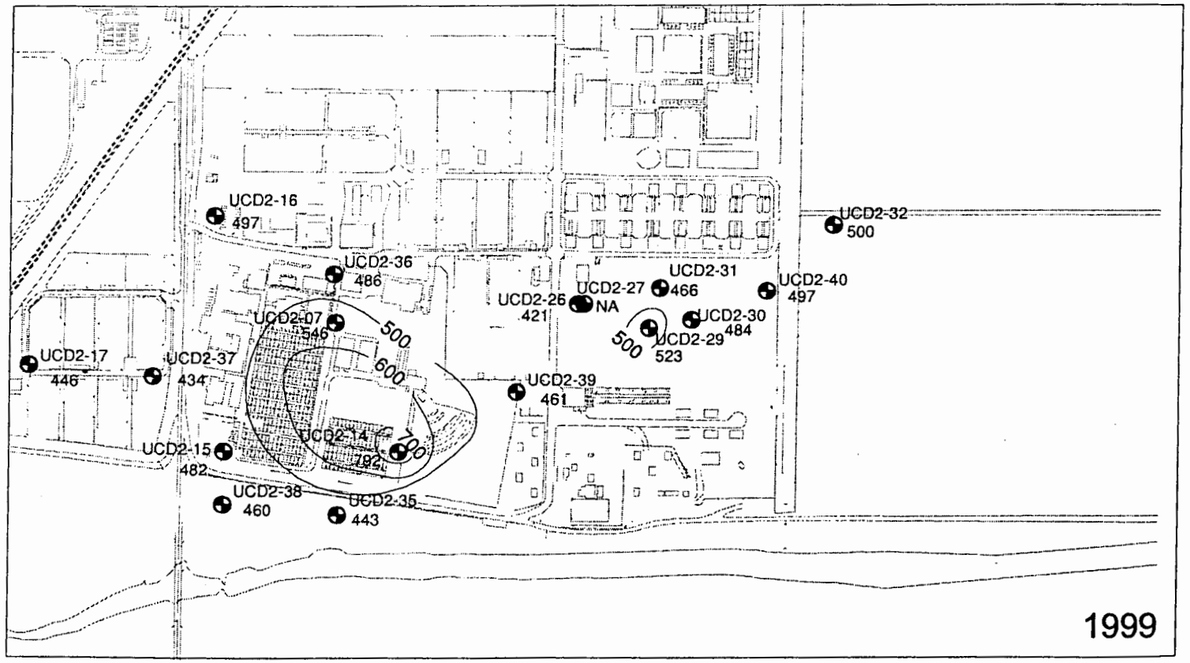

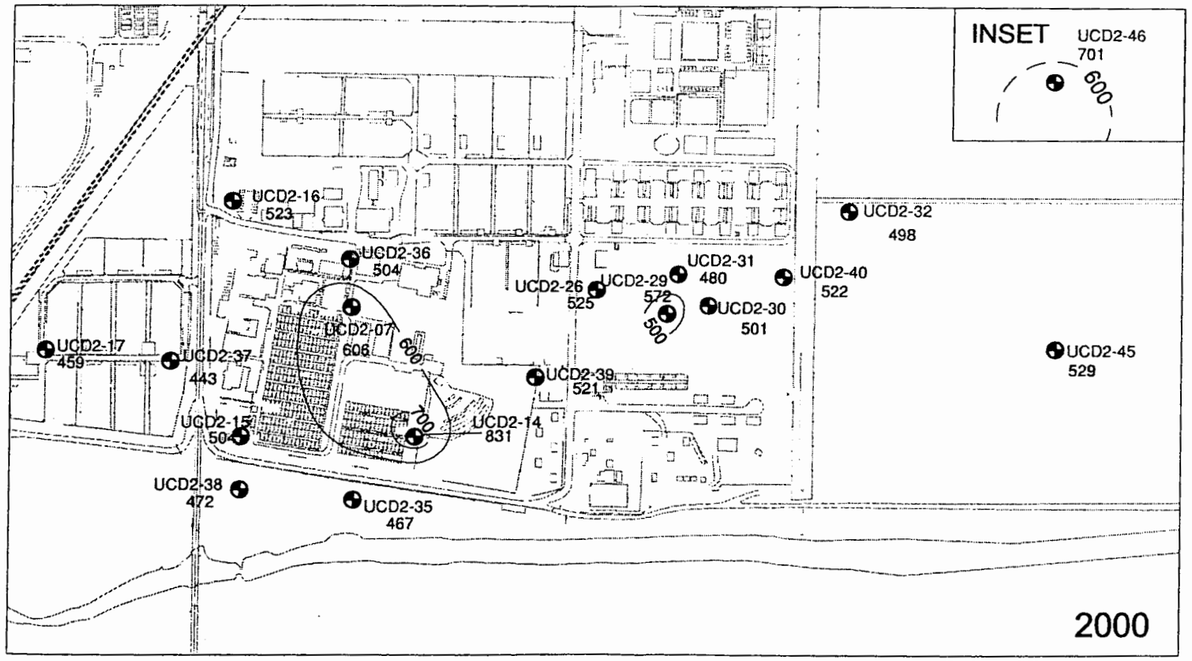

LEGEND

UCD2-17 HSU-2 Monitoring Well
All results reported in pCi/L
Results represent average of quarterly data
NA = Not Analyzed
ND = Not Detected

TDS ISOCONCENTRATION CONTOURS IN HSU-2, 1997 THROUGH 2000

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FIGURE 31

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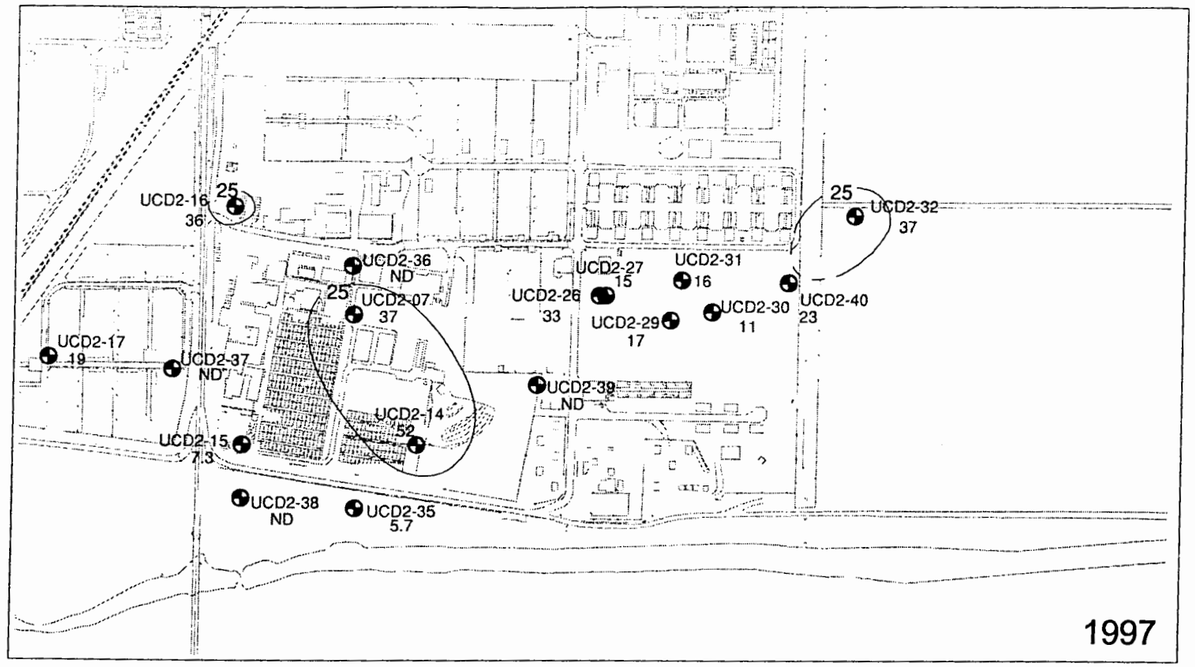

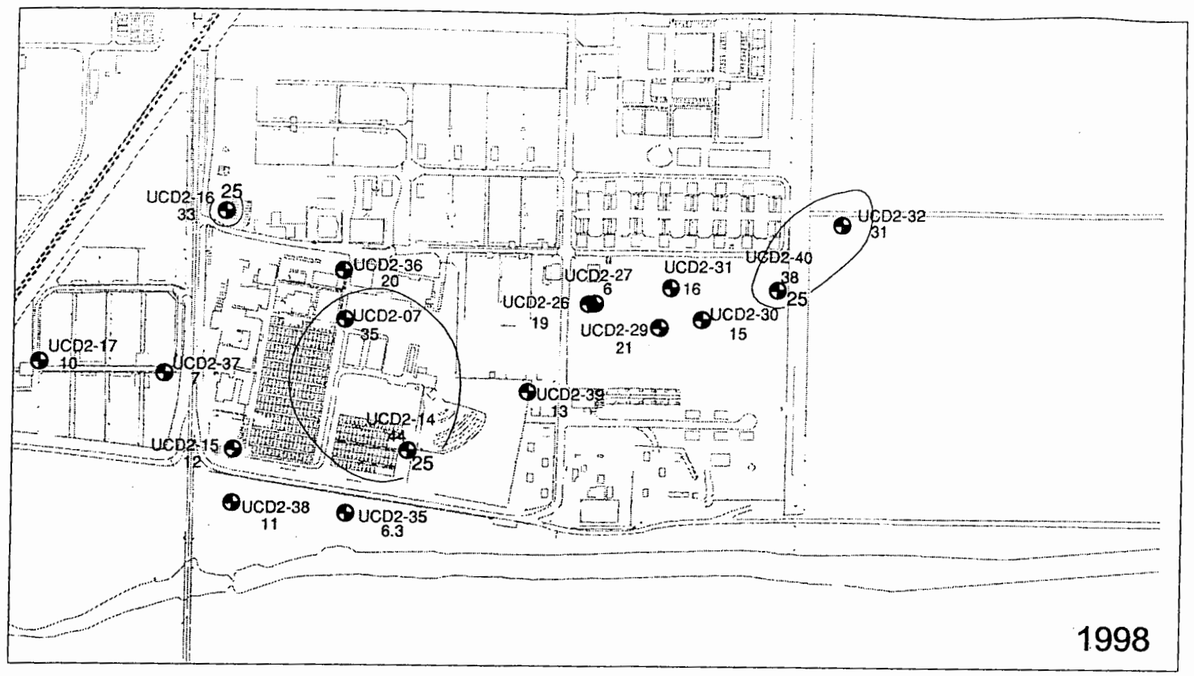

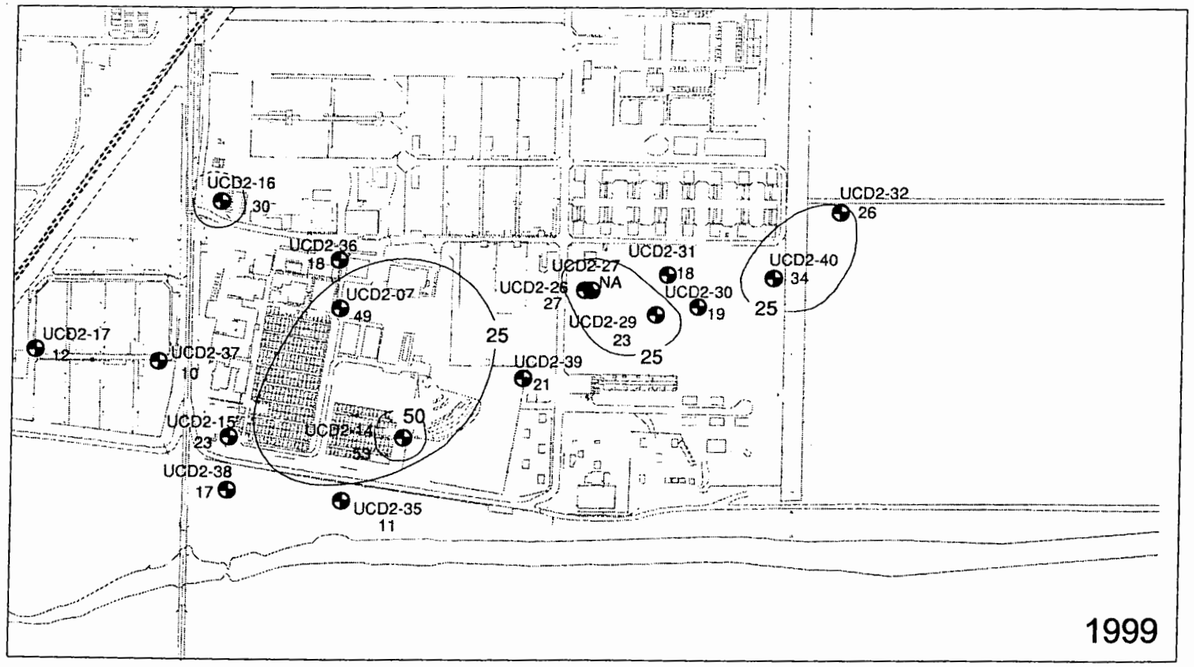

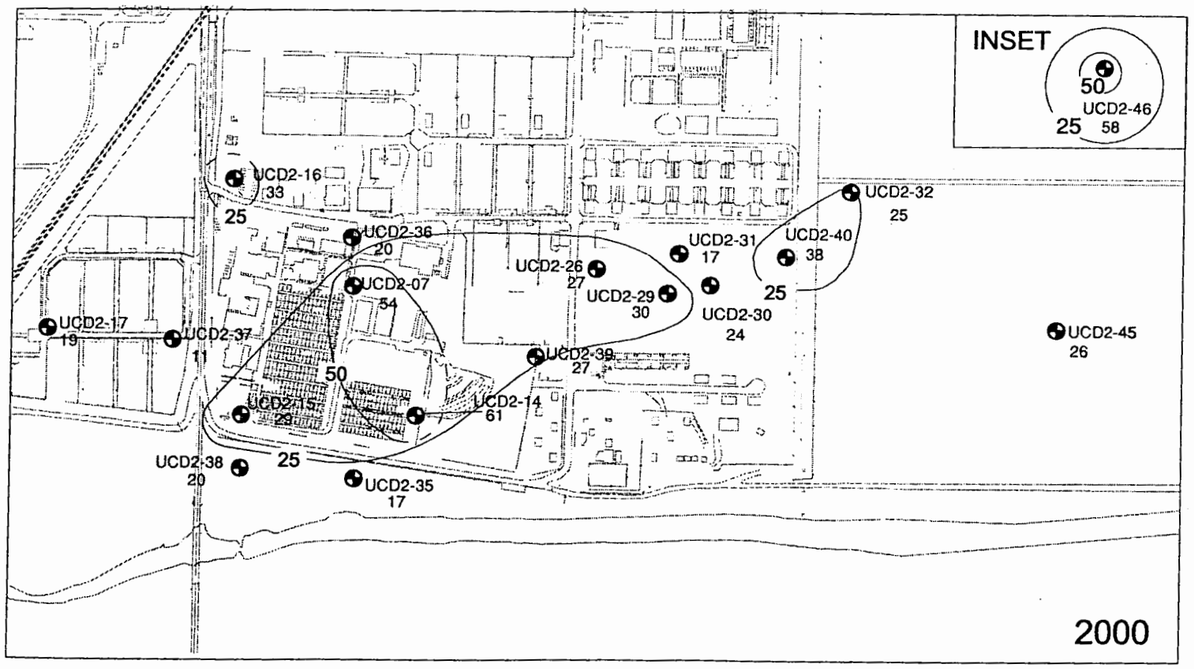

LEGEND

- UCD2-17 HSU-2 Monitoring Well
- All results reported in pCi/L
- Results represent average of quarterly data
- NA = Not Analyzed
- ND = Not Detected

CHROMIUM ISOCONCENTRATION CONTOURS IN HSU-2, 1997 THROUGH 2000

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